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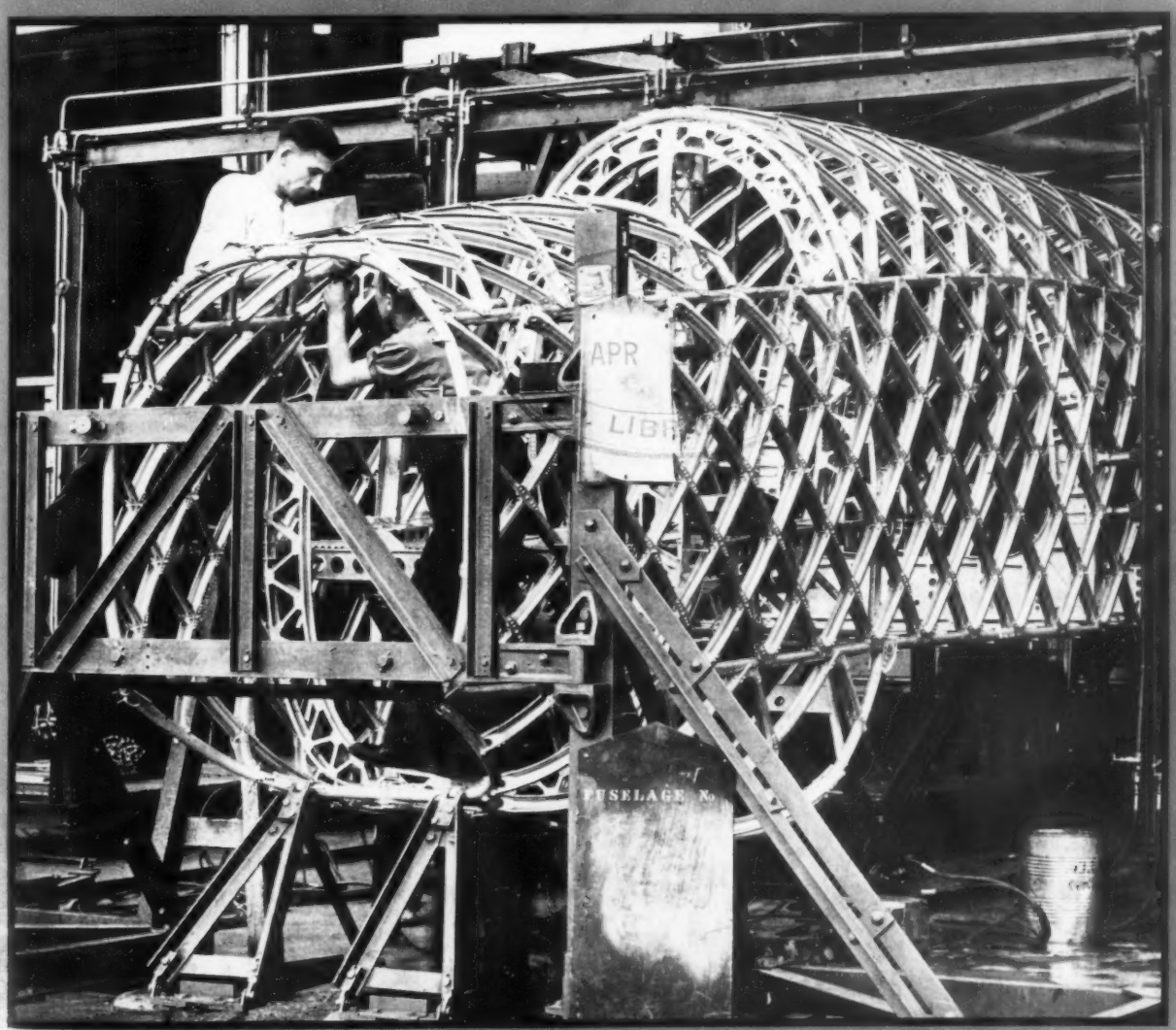

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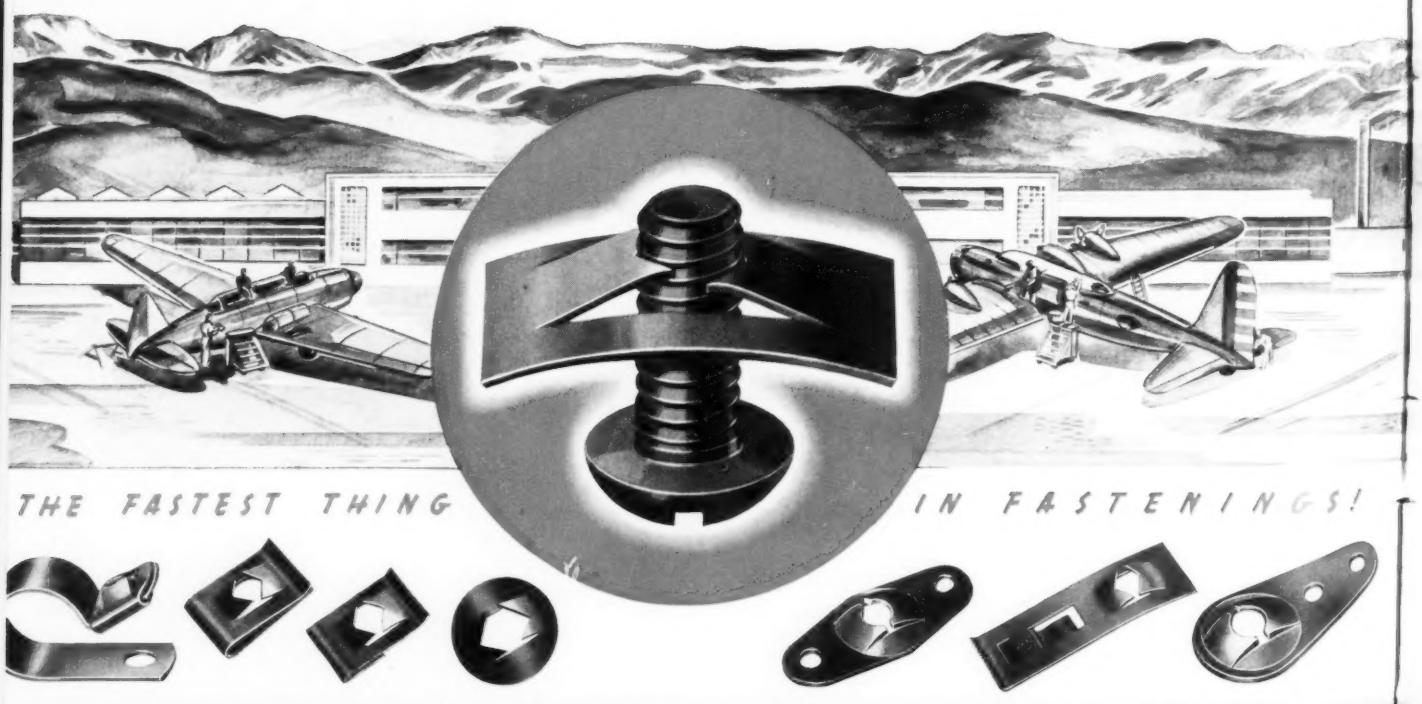

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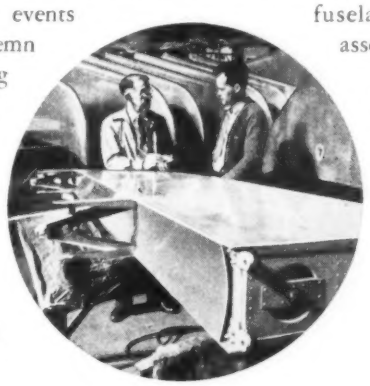

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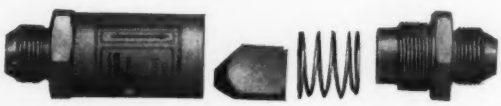

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JOURNAL OF THE AERONAUTICAL SCIENCES

AERONAUTICAL REVIEW SECTION

MARCH, 1942

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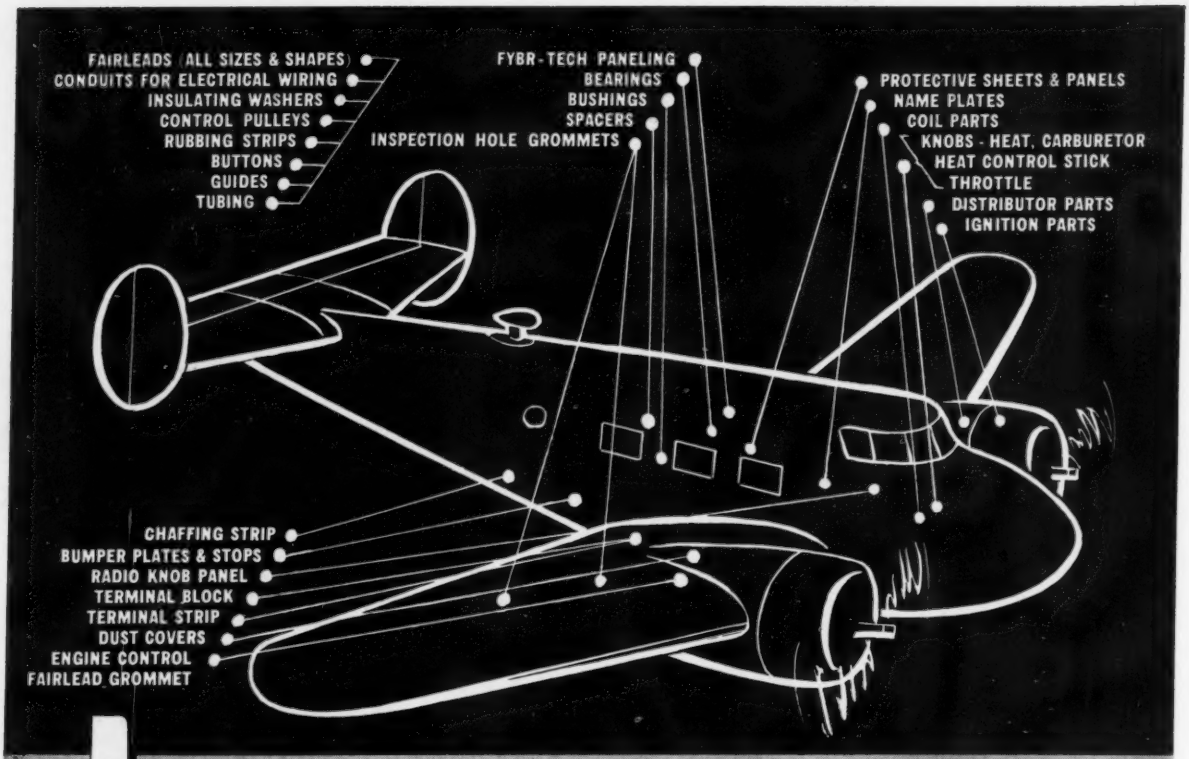

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AERONAUTICAL REVIEW

Publication Delays

THE LATENESS OF ISSUE of the publications of the Institute has resulted from circumstances which have arisen since the United States entered the war. While the so-called censorship has been liberal in its interpretation of articles submitted for approval, the time lag that is necessary in finding specialists in the Army and Navy who can critically read technical papers has been one factor causing delay.

Not the least difficulty has been the matter of the leaves taken from the staff of the Institute by men who have entered military or governmental service. Lt. Col. Doolittle went on active duty in the middle of his term as President. Dr. Hunsaker had to be given leave as editor of the *Journal* for service with the Navy, and since he has become Chairman of the National Advisory Committee for Aeronautics he found it necessary to resign for the duration. Other members of the staff are on active duty in the Air Corps and the Navy.

These direct losses, to which are added the problems of priority, are creating increasing delays but the Institute is not alone in finding present conditions worrisome.

Technical Data

Under the limitations imposed by wartime censorship upon the general press, it is becoming increasingly difficult for newspapers, trade magazines, and even some of the more widely-circulated technical journals to perform their normal functions of publishing information. Details relating to new designs of aircraft or other mechanical devices, results of experiments with new materials, tests of the performance of completed machines and countless other matters of engineering interest can no longer be given the broad publicity which they deserve, because such data would undoubtedly be of value to the enemy. Any publication of general circulation might become available to those who might be serving interests hostile to ours. Nevertheless, it is necessary to continue the dissemination of useful technical and commercial information, so that loyal interests may receive the benefits of the discoveries of other scientists and the experiences of other industrialists.

One solution of this problem would seem to lie in the field of technical meetings, such as those of the Institute of the Aeronautical Sciences, whose tenth annual meeting is reported elsewhere in these pages. In such a gathering, disclosures can be made because it is assured through careful registration, that no subversive elements are present. Any facts and figures to be kept in confidence could be so specified, the hearers being asked to treat such information as a matter of trust.

To the extent that the circulation of the journals of the scientific societies is controlled, such media are particularly suitable for the dissemination of other non-confidential technical information that is not of broad enough scope to be published in the general press.

Obsolescence in Books

The Book Review Department has had a war problem of its own in the past two issues. A number of newly published books must suddenly be considered "obsolete" because the hypotheses they assume are no longer true under war conditions or have been obscured temporarily by pressing military problems.

This, however, is not a problem confined to aeronautical books. Many developments by the aeronautical industry have suffered a postponement of application, notably certain types of aircraft. But because their purposes were primarily commercial or civilian they have not been put into discard. Military progress has been based, to some extent, on their peacetime operation development and they have been merely adapted to military utility.

A book should not be neglected just because its title, jacket or exploitation is purely of interest in peacetime. If it is authoritative and replete with information that was of importance before December 7th, you may be sure that it offers some contributing factor upon which present aeronautical operations are based and that sometime in the future it will resume its rightful place, if only as a link in the chain of development.

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News Review

January 10. Pan American Airways opened a new route to China across the South Atlantic to Khartoum, Egypt, to Burma and Hong Kong, connecting with the China National Aviation Corporation's system. The newly charted portion of the air route is the 3,800-mile jump across the Indian Ocean from Rangoon to an unnamed port on the African continent.

January 10. The first of a large order of troop-carrying gliders arrived at Wright Field to undergo acceptance tests.

January 11. The War Department announced that 300 private aircraft will be acquired through the Defense Supplies Corporation for military and naval use.

January 12. The Senate approved a bill posthumously promoting the late Col. William Mitchell to the rank of major general.

January 12. The Musick Memorial Center was opened in Aukland, New Zealand by Prime Minister Peter Frazer on the fourth anniversary of the loss of the Samoan Clipper with her pilot, Captain Edwin C. Musick.

January 13. President Roosevelt appointed Donald Nelson chairman of the War Production Board.

January 13. The Senate Military Affairs Committee indefinitely postponed hearings on a measure introduced by Senator McCarran for the unification of U.S. air forces.

January 15. The Truman Committee report was submitted to Congress. It criticized certain U.S. aircraft as not being of modern design and fit for combat.

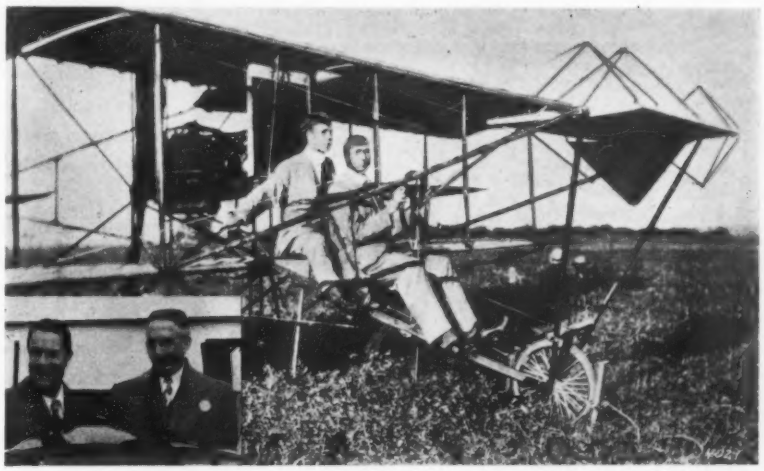
January 15. President Roosevelt appointed L. Welch Pogue, former general counsel of the Civil Aeronautics Authority, to be chairman of the Civil Aeronautics Board.

January 17. American Export Airlines' first Vought-Sikorsky four-engined transatlantic flying boat was launched at Stratford, Connecticut.

January 18. Prime Minister Winston Churchill returned to England in the British Overseas Airway Boeing Clipper after a visit in the United States.

January 19. Brig. Gen. Donald R. Connolly, military director of civil aeronautics, ordered the establishment of passenger and cargo priorities for the nation's airlines.

January 20. The War Department announced that U.S. Army bombers sank a Japanese cruiser and fired a tanker 100 miles off Jolo in the Philippine Islands.



In 1911 Glenn I. Martin took an obscure acrobat named Joe E. Brown for a flight in his pusher. Inset—recent picture of Joe E. Brown and the President of Martin inspecting a B26.

January 20. Dr. Samuel Bosch, Argentina's Minister of Civil Aviation announced that Argentina and Brazil had reached an agreement whereby both nations would participate in a plan to establish a national air mail service, replacing the recently nationalized Condor Air Lines, which had been German-controlled.

January 23. The House of Representatives passed a $12,500,000,000 appropriations bill providing for the construction of 33,000 airplanes, 23,000 of which are to be combat craft.

January 25. U.S. Army Flying Fortresses attacked a convoy of Japanese transports in the Macassar Straits.

January 27. Prime Minister Winston Churchill informed the House of Commons that U.S. Army aircraft would take part in the defense of England and would participate in actual raids over Germany.

January 27. At the Tenth Annual Honors Night Dinner of the Institute of the Aeronautical Sciences in New York, Juan T. Trippe, president of Pan American Airways received the Daniel Guggenheim Award for his contributions to the development and operation of oceanic air transport. Dr. Theodore von Kármán received the Sylvanus Albert Reed Award; Melvin N. Gough, the Octave Chanute Award; Ernest G. Stout, the Sperry Award; Maj. Harry G. Armstrong, the John Jeffries Award; and Dr. Horace R. Byers, the Robert M. Losey Award.

January 29. Major General Mason M. Patrick, former chief of the U.S. Army Air Service, died at the Walter Reed Hospital at the age of 78.

January 29. Major General M. F. Harmon, commander of the Second Air Force, was assigned as Chief of Staff for the Army Air Force, being replaced by Maj. Gen. F. L. Martin, former air commander of Hawaii. Harmon replaces Brig. Gen. Carl Spaatz who has been assigned as chief of the Air Force Combat Command.

January 31. The Navy Department announced plans for the training of 30,000 pilots a year by renting the facilities of four universities for the task.

January 31. A Pan American Airways Clipper, returning from Rio de Janeiro with Undersecretary of State Sumner Welles and the other delegates to the conference of American foreign ministers, set a new airline speed record of 28 hours for the flight from Rio to Miami.

February 6. Dr. T. F. Tsiang, Chinese government spokesman, suggested a system of air transport for supply should the Burma Road be cut off.

February 7. The Army announced that a program for enlargement of the Air Forces to 2,000,000 officers and men had been launched. Half that number are to be mustered by the end of 1942.

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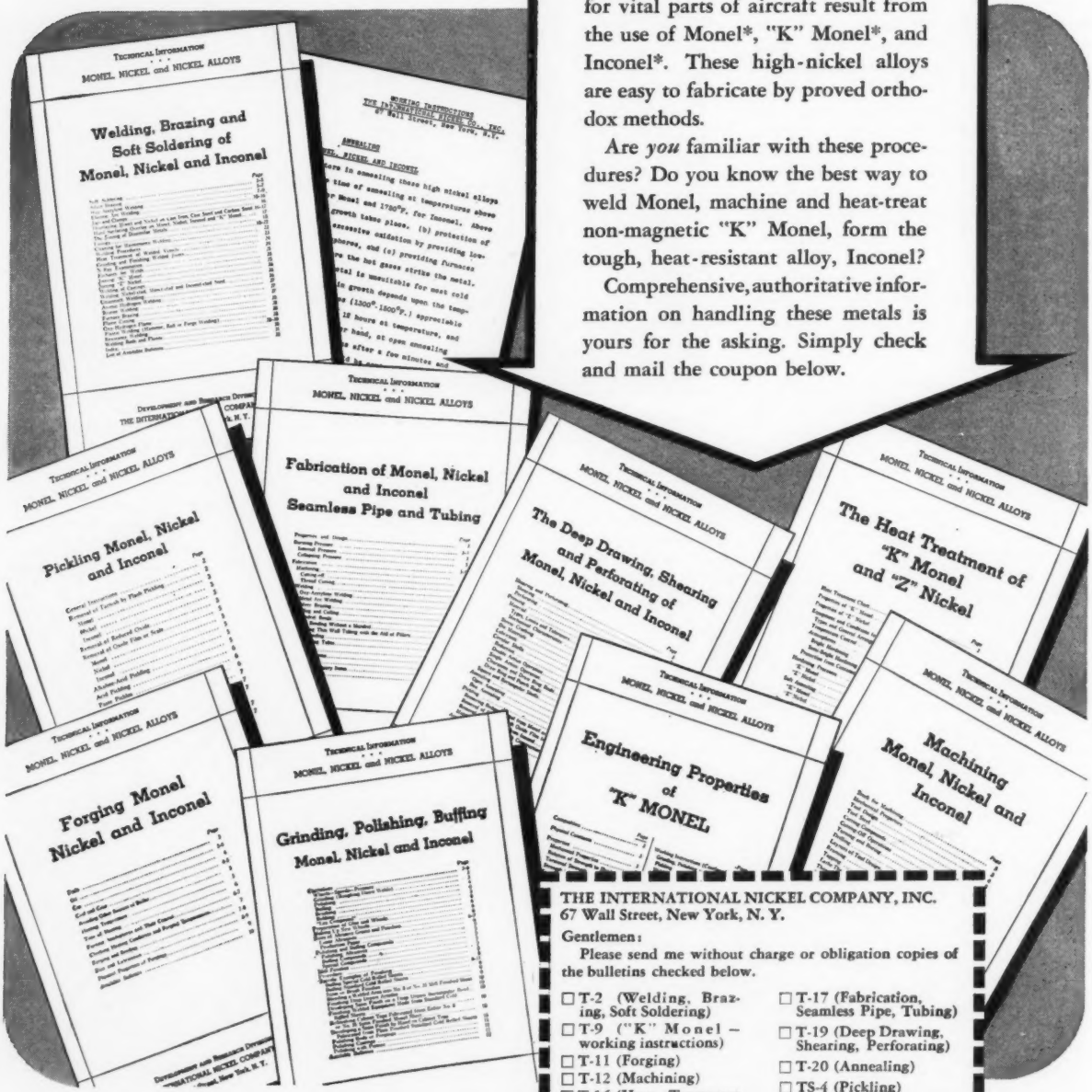
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The Tenth Annual Meeting of the Institute of the Aeronautical Sciences

ALEXANDER KLEMIN*

Introduction

The Tenth Annual Meeting of the Institute of the Aeronautical Sciences was held as in previous years at the Pupin Physics Laboratory of Columbia University in New York, January 28–30, 1942. A total of 67 papers were presented in 15 technical sessions during the three-day meeting. Over 800 attended the meetings.

In this report of the meeting the precise order in which the sessions occurred will not be followed nor will papers be classified in exactly the manner of the meeting. Unfortunately, certain of the papers presented will not be found in this review owing to lack of reprints but this in no way reflects on the value or timeliness of the papers omitted.

Aerodynamics

Frederick C. Phillips, of The Glenn L. Martin Company in a paper entitled *A Kinetic Energy Correction to Predicted Rate of Climb* discussed an idea that may be novel to many aerodynamists not specially interested in performance test interpretation. In climb performance calculations it is generally assumed in the interest of simplification that there is zero acceleration along the flight path. Neglect in taking into account change of kinetic energy with time results in an error in climb. When this error is taken into account, it is found that performance calculations as made at present are optimistic. The error appears to increase with high loadings, high power and high altitude operation. As present tendencies are towards extremely high altitude operation as fast as supercharging techniques will allow, the error must henceforth be taken into account and subtracted from computed rates of climb. An example of the magnitude of the error lies in the fact that for a hypothetical bomber with wing loading of 50 lbs. per sq.ft, aspect ratio 10, normal power loading 10 lbs. per hp. an error of 6 per cent in time of climb to 40,000 ft. was discovered.

On multi-engine airplanes having propeller blades whose tips approach near the fuselage, vibrations have been observed which can be traced to aerodynamic interference between the propeller tips and the fuselage. Albert Gail, University of Minnesota, in his paper *Further Developments of the Theory of Propeller Tip Interference* presented a qualitative theory. The fuselage with its axis inclined is in a definite upflow, partly due to the inclination of its axis and partly to the circulation round the wing. Near the walls of the fuselage this upward velocity naturally increases. With propellers rotating in the same direction, the tips of the starboard or right side propeller experience an appreciable decrease in velocity; those on the port or left side experience an increase in relative velocity. Vibration naturally must follow. The matter of periodic changes of thrust and torque by means of converging Fourier series without coming to absolutely definite conclusions but suggesting further experimentation and analysis was discussed. A possible remedy would be, of course, to reverse the sense or rotation of the starboard or right side propeller.

In the study of directional stability the effect of the propeller is very often neglected. Such neglect is not justified and L. B. Rumph, R. J. White and H. R. Grumman, of the St. Louis Plant of Curtiss-Wright Corporation, have done well to review study of the subject in a paper (*Propeller Forces Due to Yaw and Their Effect Upon Airplane Stability*), which is perhaps the first technical discussion of the subject since R. G. Harris and H. Glauert considered it in British Reports and Memoranda in 1918 and 1919. Harris and Glauert predicted only half of the forces in yaw indicated by tests. Numerical solutions in this paper are in closer agreement with experiment because they have taken into account the modification of lift produced by an airfoil when operating in oscillating airstream. Another step forward has been made by the authors because they have taken account of the propeller blade form which Harris and Glauert neglected. When the blade form is taken into account, the paper indicates clearly that propellers having a wide root chord section will produce greater side force due to yaw than would be induced by propeller blade having a narrow root chord. This is an interesting conclusion since a high load pusher airplane (whose side area placed behind the center of gravity must assist weathercock or directional stability) will probably require a propeller with a wide root chord, so that its favorable stability effect will be still further increased. In pitching the effects are similar. In pitching also, the pusher propeller will be more favorably situated for longitudinal stability—particularly so again if it has a wide root chord.

Lee Arnold, Republic Aircraft, presented a fine but complex mathematical paper on *Vector Solution of the Three Degree Case of Wing Bending, Wing Torsion, Aileron Flutter*. It is impossible in this review to present the mathematical arguments even in outline. The author's introduction, however, gives a fine statement of the objectives sought and the methods employed. "It has been seen by various investigators that the two degree analysis based on Theodorsen's two dimensional theory is inadequate for the accurate determination of the critical flutter speeds of an oscillating airfoil-flap system. Various graphical methods have been devised to eliminate the computations required in the solutions of the various two degree cases, but until now no simplified method of solution has been developed for the three degree case of flutter. Though the method of the three degree case has been straightforward and routine in character, the actual inherent complexity of the computations involved is such that it warrants the following simplified vector method of solution. The solution is based on the fact that the components of the vibratory determinant are complex in form (of the form $a + ib$), and, therefore, can be represented vectorially. The expansion of the determinant can be separated into two vectors, functions of the flutter speed and the flutter frequency. That combination of the speed and frequency which will cause the two vectors to be identical will be the flutter speed and flutter frequency. It has been the author's experience that the determination of the critical flutter speeds and frequencies by the usual method of solution requires approximately thirty to forty man-hours for a given case, whereas it has been seen in practice that the method presented here can diminish the labor to approximately five to eight man-hours."

Airplane Design

The first paper presented at the design meeting was on *Tricycle Landing Gear Design* by E. S. Jenkins and A. F. Donovan of the Buffalo Plant of Curtiss-Wright Corporation. The paper is a thorough analysis of the problem and includes a mathematical study of every aspect of the problem—geometric arrangement, location of wheels, relationship between tread, wheel base and resistance to turning over, design of the nose wheel, fundamental causes of shimmy, construction of

* Guggenheim Research Professor of Aeronautics, New York University.

fluid dampeners, ground handling, maneuverable flaps and steering devices. It is impossible here even to adumbrate the mathematical treatment but the conclusions will be of interest to every airplane designer. The authors suggest that the nose wheel should be placed as far forward of the center of gravity as possible since that reduces critical design loads on the nose wheel, decreases the probability of pitching oscillations, and increases the resistance of the airplane to turning over. At the same time, the distance aft of the wing aerodynamic center should not exceed the maximum value at which the airplane will be longitudinally stable when taxiing on only the rear wheels at take-off speeds. Unfortunately, increase in the distance of the rear wheels after the C.G. also results in decrease of directional stability and a small reduction in the resistance to overturning. The tread should be sufficient so that, in a landing with side drift, the wheels will skid sideways and not overturn the airplane. The larger the tread the more maneuverable the airplane will be while taxiing. Satisfactory ratios between the values of wheel-base and tread are best obtained by careful application of the mathematical criteria given in the paper and cannot be arbitrarily defined. Space unfortunately will not permit reviewing other conclusions in detail. We have to summarize by quoting the authors' own abstract. "The problems related specifically to the design of the nose wheel are next examined. A basis for the selection of nose wheel and tire size is given. The fundamental causes of shimmy are reviewed including the effects of trail, caster angle, wheel offset, tire type, and moment of inertia of castering parts. Shimmy elimination is discussed with special reference to elimination by damping and including methods of calculating the amount of damping necessary to prevent shimmy. The construction of fluid dampeners is described and their damping characteristics compared to the simpler mathematically defined types of damping. An empirical relationship between the volume of a vane type hydraulic dampener necessary to prevent shimmy and the static nose wheel load is given. Ground handling and maneuverability, construction and installation difficulties, castering locks and stops, and steering devices are briefly discussed. Conclusions as to the best arrangements must be based on the characteristics of the particular design. As a partial check on the validity of the criteria developed, the results of applying them to some successful tricycle gear airplanes are summarized."

Harold E. Hoben, of American Airlines, discussed *Fatigue Failures Affecting Air Transport Aircraft.* Even though fatigue failures generally plague airline maintenance men rather than airliner manufacturers, the paper was quite rightly presented in the design session. The most skilled designer is sometimes apt to be satisfied with fine structure, streamlined aerodynamics and well installed power plant and the minor troubles of continued service are apt to escape his attention. The author has done a service to airplane designers by defining and listing specifically some of the fatigue or vibration failures which have been found in service. The lists were based on airplane parts on which at least 20 occurrences of fatigue cracks or failures had been experienced in one airline plant alone during the past three years. Even though in each case careful inspection resulted in the damage being discovered and corrected in time to prevent a serious accident, the troubles are worthy of careful study by designers. Only a few typical examples of the difficulties encountered can be cited here, such as: (1) Oil radiator air scoop made of sheet aluminum sections formed and welded in slipstream—frequent fatigue cracks at attachment flange. Thin stainless steel plates reinforcing the flange eliminate the difficulty. (2) Similar troubles were encountered with carburetor air scoop and air scoop control shaft in which the butterfly valve was subjected to pulsating air blows of the propeller. (3) Engine mount—following change in propeller drive gear ratio, failures in welded steel tubular structure were discovered at the rate of one a day. Excessive resonance in the tube supporting the oil radiator was cured by stiffening the tube to alter the natural frequency of the oil radiator. (4) Engine cowling—mounted rather loosely on the engine is subject to tremendous engine and propeller vibration. Fatigue cracks are routine occurrence, usually found running between holes where riveted reinforcements have been added. Troubles are also found in cowling flat cables. (5) Outer wing spar—after several thousand hours of service, fatigue cracks were discovered to be forming at sharp angles of the recessed cutout in the front spar cap strip, which was an extruded angle section of aluminum alloy material. Corners containing cracks were cut back further to remove the damaged material and then were smoothly finished to a large radius. A design change has been made to eliminate the sharp angles and later model airplanes should not give trouble at this point. (6) Other difficulties were in wing attachment angles, propeller control levers, rudder and brake pedal supporting arms, hydraulic hand pump handles and pilot seats. The author thoroughly proved his point that fatigue is one of the major problems of airline maintenance. Fatigue failures in engines and propellers have become a rarity but fatigue failures in other aircraft components are still to be eliminated and could be eliminated if sufficient effort is made. First, the manufacturer and designer must recognize their large share of responsibility for solution of the problem. Second, complete information on fatigue characteristics of materials as used in engineering structures (particularly where notches and rough surfaces are encountered) must be placed in the hands of the designer. Third, and most important of all, the designer must consider occurrence of repeated loads in every part of the airplane structure, whether primary or secondary.

Ralph H. Upson, of Stout Skycraft Corporation in *New Developments in Simplified Control* continued a series of papers which have from time to time dealt with the problem of the airplane particularly suitable for private flying. While his discussion brought up few points not previously taken up, he discussed the whole problem in a comprehensive and well reasoned manner. In speaking of the *engine position relative to the wing*, the author seemed to favor the pusher—one reason being that the pusher can be made to give less change of trim than a tractor as between power on and power off. The pusher engine can be mounted considerably higher, thereby helping to counteract the usual nosing up tendency when power is applied. Another reason is that more effect can be obtained by a change in slope of the thrust line in a vertical plane. With a pusher it is also possible to maintain the same stalling characteristics for power off or on. The main advantage of the pusher, of course, is vision. In relation to the *tricycle landing gear* the author concentrated his attention on the *steerable front wheel.* A fixed front wheel seems definitely better than one which might be turned in the wrong direction. Yet the steerable front wheel is generally desirable and there are at least three cures for the tendency to steer in the wrong direction. First, let the pilot forget that he is flying an airplane as soon as he makes contact with the ground, and then imagine that he is in an automobile to be controlled accordingly (by steering into the bank). Second, with a suitably designed front wheel, simply release the control entirely and let the dynamics of the situation take charge. Third, provide a wheel spacing which in itself will prevent overturning. Neither of the first two measures are likely to be sufficient in themselves because both depend on abnormal action or inaction by the pilot. Even aside from wrong control, the possibility must be considered of the front wheel dropping into a rut, or that positive steering must be used to avoid obstructions. Hence, it is important to provide enough wheel base and tread to take care of any situation that may be reasonably expected. This condition is particularly critical with the high wing arrangement because of its relatively high center of gravity. In regard to the *position of rear wheels*, it is important to put the rear wheel a substantial distance behind the most rearward C.G. but there must be no interference with getting a sufficient angle of attack for a proper take-off at a

speed preferably 20 per cent above stalling. In discussing *lift control*, he pointed out that the flap has usually been operated as a combined lift and drag control by means of a separate flap control lever. In his opinion, with the relatively low-drag flap, of which there are several types now available, the rational place for flap control is in direct coordination with the elevator. With a proper linkage ratio in the system, it should be possible to control lift not only by angular deflection of the entire airplane but by combining this process with the direction of the flap. The *two-control* airplane has been discussed again and again with advantages and disadvantages thoroughly threshed out. The two-control airplane was advocated on the basis of coordination of rudder with the aileron system rather than relying on the side slip for supplying the necessary lateral tail forces. The coordinated rudder movement should be powerful enough to overbalance any possible aileron yaw. A good argument for coordinated rudder and aileron is as follows: if aileron and elevator alone are used for control, then it is difficult to use large dihedral since that would defeat aileron control. If, on the other hand, the aileron is coordinated with the rudder in a two-control ship, it is still possible to use a large enough dihedral. Here, in conclusion, is the ideal specification for the modern ship for private use: It will have outstanding vision. It will neither spin nor wind up in a spiral. It will have greater wing loading and aspect ratio than present light planes. It will be stable and consistent in control throughout its entire maneuvering range. The controls will present no change from present conventional practice that would confuse a normal pilot with conventional training. Yet they will appeal to the average intelligent person who drives a car, and who finds it easy enough to handle one more control, but who is confused by any further additions. The control wheel, looking like the wheel in a car, will steer in similar fashion—whether in the air or on the ground. Its fore and aft movement will coordinate all functions of lift. A pedal will provide drag or brake force either in the air or on the ground. The throttle will be preferably a foot type, but with means of holding any desired amount of cruising power. For most purposes dual controls will be as superfluous as in an automobile. At the same time, performance can be stepped up to an extent that will leave no doubt as to the superiority of airplane over automobile for cross-country trips.

Power Plants

Only one paper was available for review, namely, *The Correction of Engine Output to Standard Conditions* by Donald S. Hersey of Pratt and Whitney Aircraft. The author essayed analysis of experimental data and theoretical analysis of the existing formulae, developed others and compared them. In order to provide a common basis for the comparison of high-performance supercharged aircraft engines, formulae were proposed for correcting the measured output to standard atmospheric conditions. An investigation of power-correction formulae is needed because the generally used formulae were developed for naturally-aspirated engines and have been found to be inaccurate when applied to supercharged-engine test data. In the development of the proposed correction formulae, the theoretical effects of atmospheric changes on the performance of an engine's induction system units were discussed and applied in a general basic correction formula. These effects pertaining to each induction system unit were checked by comparing the unit formula with test data obtained on a specific engine. Two engine-output correction formulae, covering both full-throttle and part-throttle operation of single-stage supercharged engines, were then evolved. The accuracy of these formulae is determined by comparison of calculated engine performance with flight test data taken under various atmospheric conditions. A similar check of the generally used correction formulae was also made. A comparison of the old and new full-throttle formulae indicated that former correction errors of as much as ten per cent may now be reduced to approximately one and one-half per cent. Comparison of the part-throttle correction formulae showed that the accuracy of the rational formula is inferior to that of the generally used formula. Correction formulae for two-stage supercharged engines of the gear-driven and turbo-driven variety were finally proposed for consideration, but no flight-test proof of these latter formulae was presented.

Structures

It is a good many years since experiments on load factors have been released by any governmental service. Therefore Edward I. Ryder's review of load factor measurements made by the Civil Aeronautics Administration (*Load Factors Obtained on Civil Airplanes in Acrobatic Maneuvers*) was very welcome.

One feature of the tests made by the Civil Aeronautics Administration was first conducted by using smooth technique and then by using rough technique to simulate the action of an inexperienced student pilot. Thirty-eight airplanes were used.

The load factors reported were regarded by the Civil Aeronautics Administration as sufficient basis for a revision to the present maneuvering load factor requirements for small civil airplanes and also a basis for the possible establishment of an acrobatic category. The author is of the opinion that if an acrobatic category is set up for civil airplanes, it would be well to make some allowance for maximum values of accelerations recorded in the present series to obtain limit factors suitable for semi-skilled student pilots.

The paper by N. J. Hoff of the Polytechnic Institute of Brooklyn on *Stress Analysis of Rings for Monocoque Fuselages* is excellently though briefly summarized by the author as follows: "The calculation of the moment distribution in closed rings for monocoque fuselages has a considerable literature. In all the papers that deal with the effect of the sheet covering of the fuselage the tacit assumption is made that the shear stresses transmitted from the ring to the covering can be calculated with sufficient accuracy from the formulae of Strength of Materials which are strictly valid only at some distance from the points of application of the loads. It is likely that this assumption is reasonable enough in the case of strong and stiff rings which transmit heavy loads. By this assumption the problem is reduced to the determination of the moments in a closed ring upon which a known system of self-equilibrating forces is acting. A closed ring loaded in its own plane is three times statically indeterminate. It can be reduced to a 'simple,' or statically determined structure by making a complete cut through it. The bending moment, the axial force, and the shear force acting in the imaginary cut are then the three "unknowns" which can be calculated by strain energy methods. Such a procedure is followed in Lundquist and Burke's paper in which the unknowns are determined by Castigliano's theorem. With a view to taking advantage of the symmetry-properties of the ring the cut is made at the topmost point of the ring and the origin of coordinates is assumed to be at the same point. Their paper also contains references to earlier literature. Of the more recent publications Ruffner's and Wise's papers deal with circular rings and make use of the same system of unknowns, while Liepman follows Müller-Breslau's lead in assuming the unknown quantities to act at the "elastic center" of the ring. The above choices of the unknowns, as a rule, result in obtaining the resultant moments in the indeterminate structure as small differences of large quantities. Indeed, Ruffner suggests carrying out all calculations to five significant figures in order to be sufficiently accurate. This requirement may lead to great difficulties in cases where the shape of the ring is not known analytically. In the present paper suggestions are made for a more convenient choice of the unknowns. Moreover, the use of graphical methods is shown for the calculation of the bending moments in the "simple" structure. It is believed that the procedure outlined is of advantage in the cal-

culation of rings the shape of which cannot be expressed by simple analytical formulas. Throughout the paper it is assumed that Hooke's Law is valid, that the strain energy due to axial and to shear forces can be neglected, and that the direct stress distribution over the cross-section due to bending is linear. Bending moments are considered positive if they cause tension on the outside of the ring."

A problem often encountered in structural analysis is that a deep beam under load, if not adequately supported in a lateral direction, may become unstable and buckle sidewise at a stress well within the commonly calculated bending strength of the beam. This type of failure is similar in nature to the buckling of a column under end load and was discussed by H. N. Hill of the Aluminum Company of America in a paper entitled *The Lateral Instability of Unsymmetrical I-Beams.* The problem cannot be adequately handled simply by considering the column strength of the compression flange of the beam. The stability of the beam depends on its resistance to twisting as well as on its lateral bending stiffness. Formulae are available for determining the buckling strength of I-beams under various loading conditions. These formulae apply to I-beams of symmetrical cross-section. Occasionally, however I-beams are encountered in which both flanges are not alike. In this paper an expression is derived for the bending moment at which such a beam will become unstable, when subjected to constant bending throughout its laterally unsupported length. The expression includes a term which takes account of varying degrees of restraint at the ends of the unsupported length. Tests were made to determine experimentally the critical bending moment for several high strength aluminum alloy I-beams in which one flange was wider than the other. The results of these tests were found to be in reasonably good agreement with corresponding values determined from the theoretically derived expression.

A paper of a novel character was presented by F. R. Shanley of the Lockheed Aircraft Corporation—*Elastic Theory As a Tool in Sheet Metal Forming Problems.* The author pointed out that a gap exists between scientific knowledge of materials and practical application of that knowledge to the production technique of sheet metal forming. He might have gone further and said that a gap exists between scientific knowledge of materials and the practical application of that knowledge to almost any shop process. It is very gratifying therefore to know that the production research group of Lockheed Aircraft has given special attention to an important problem of this type in an effort to put sheet metal forming on a scientific basis. Before an analytical attack on forming problems is undertaken, it is necessary to obtain physical data for the metals involved. The ordinary stress strain diagram suitably modified and extended is the key to almost all forming problems. This means that there is really no mysterious or unique property which is a measure of formability. It is only necessary to extend our knowledge along lines already established. The ordinary stress strain diagram in the tension range must be extended to complete the stress strain range up to maximum elongation. Such information is often useful in dealing with buckling problems. Fig. 1 illustrates what is meant quite clearly. Maximum elongation is the amount the material can be stretched before breaking. The usual stress strain diagram reflects one way loading failure since forming operations involved go only part of the way to failure. The behavior of metals after the load has been released should be studied. In many problems it is important to obtain data on combined loading, combinations of shear and tension, etc. After extended stress strain data had been obtained, the author and his associates proceeded to an analytical discussion of the forming process and took up such problems as bending, maximum bending radius, springback, spring distribution in bends, bending curved flanges, cutouts, stretching, etc. Diagrams were indicative of strains and stresses of equilibrium conditions during forming processes. It may be said that every forming process has been illuminated by the paper and that it is really an effort to bring theory and shop together, which is of the greatest possible importance to aircraft. Again, very practical suggestions are given to the shop by the analytical work—as, for example, in eliminating springback by combination of bending and stretching.

A contribution by Vincent C. Trimarchi of the Rensselaer Polytechnic Institute was entitled *Bending and Torsional Design Charts for Round Chrome-Molybdenum Tubing.* Design charts based on Figs. 4.20 and 4.22 of ANC-5 were developed. These may be used for the design of round chrome-molybdenum tubing either in bending or torsion alone, or under combined bending and torsion. The general case of combined bending and torsion is simplified by use of the "equivalent" moments method and is treated in detail. Several examples illustrating the use of the charts were included. Some recent systematic combined bending and torsion tests on representative tube sizes were found to substantiate the design charts satisfactorily.

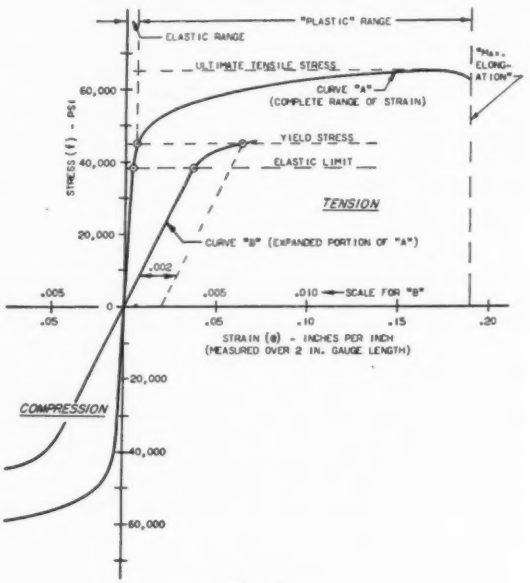

FIG. 1.

For the past three years there has been increasing interest in the application of magnesium alloys to aircraft structures to determine possible weight saving and general stability of magnesium alloys for aircraft production. The Bureau of Aeronautics and the Dow Chemical Company have cooperated in design construction and static testing of a wing which was directly comparable to aluminum alloy structure. The project was described in a paper *Design and Static Tests of A Magnesium Alloy Wing* by Emerson W. Conlon, University of Michigan, and John C. Mathes, Dow Chemical Company. The wing was an outer wing panel designed for one of the North American low wing monoplane trainers and well known to the industry. The outer panel is of the conventional semimonocoque construction with a single main shear web located at 30 per cent of the chord. The center section has two shear webs with the fuel tanks mounted between these webs. The leading edge is practically non-existent due to cutouts for the landing gear. The outer and center panels are joined by external bolting angles, and a plate rib at this point distributes the shear from the single web of the outer panel to the two shear webs of the center section. On the experimental Dowmetal outer panel, the main shear web consists of a tension field web of Dowmetal J-1 alloy attached to "T" shaped flanges extruded from Dowmetal Z-1 alloy. The skin is cold rolled Dowmetal J-1 sheet stiffened by Dowmetal

Z-1 bulb angle and Zee extrusions. The ribs, trailing edge, and wing tips were hot formed of Dowmetal J-1 alloy. The completed wing weighed 178.95 lbs. as compared to 219.82 lbs. for the aluminum panel; a saving of 18.7 per cent in weight.

The authors explain the saving in weight mainly by the fact that the lighter material provides greater local buckling stress, whether in flat sheet, curved sheet or stringer. They point out some interesting possibilities for the future in the following conclusion:

"Of equal interest with the weight saving possibilities, is the utilization of magnesium and its low specific gravity in the design and construction of more nearly pure monocoque assemblies. The savings in cost, the added space in the structure for armament, equipment, or tanks, and the smooth surface obtained are all pertinent considerations which indicate the desirability of this development. The paper previously referred to described some of the earliest tests on magnesium structures of this type. Since that time a great amount of research work has been done and additional sections constructed and tested in the compilation of additional data. This work, still in progress, should be of great value in the further development of aircraft structures."

For a good many years structural engineers have had resort to vibration of structures on the ground as an introduction to the study of both flutter and vibration. A number of vibrators have been developed and described. So far we have not seen a systematic study of the dynamics of a rigid body having two degrees of freedom, complete solutions for nodal points and coupled frequencies. Nor have we seen complete theoretical analysis made of the factors affecting the power and unbalance required to conduct vibration tests. D. Pengelley, St. Louis Plant of the Curtiss-Wright Corporation, has undertaken these very studies, together with rapid means of evaluating the position of the nodes. He has also, in his paper *Ground Vibration Tests*, prepared charts from which uncoupled frequencies as required in flutter variations may be rapidly evaluated from data observed during vibration tests. Numerical examples have been presented to illustrate the use of all principle equations and charts. This could be done with a very solid basis for both ground testing work and for subsequent flutter calculations. It is interesting to note that for given amplitude power absorbed by a wing is roughly independent of airplane size. However, for any given airplane it is from 2 to 16 times greater at torsional than bending resonance. At torsional resonance, with a tenth-inch total motion of the trailing edge, a conventional wing absorbs .0134 hp. Thus the theoretical power required is negligible, and the choice of a suitable motor depends upon the friction horsepower absorbed by the test equipment. A description is given of the Curtiss-Wright vibrograph. Fundamentally it consists of two unbalanced rotors mounted on parallel shafts 20 in. apart. They are driven in the same direction by means of bevel gears mounted on a stiff aluminum alloy torque tube. In this way the natural frequency is above the highest speed for which the vibrator has been designed to operate; namely, 2,500 r.p.m. The rotors may be connected so that they are in phase—that is, so that centrifugal forces act in the same direction, or 180° out of phase. In either case the combination can be replaced by a single equivalent rotor. The unbalanced weight on each rotor of the Curtiss-Wright Universal Vibrator is built by means of eight separate sectors cut from $^1/_8$-in. steel sheet. In this way the unbalance of each rotor may be varied from 1 to 7 lb.in.

Plastics and Plywood

It is a sign of the times that quite a number of papers dealing with plastics and allied materials were presented in either the materials or structures sessions. We prefer in this review to group them together.

George W. DeBell of The Glenn L. Martin Company, in a paper on *Use of Plastics and Allied Materials in Aircraft Construction* was of the opinion that the present war program can be materially aided by efficient use of plastics and allied materials. High impact thermosetting materials, particularly phenolics, can be used for production of many small structural parts such as radio masts, control quadrant brackets and the like. Thermoplastic materials, particularly acrylics, can be used to manufacture self supporting transparent enclosures such as windshields. Larger aircraft assemblies such as bomb bay doors, wing flaps, etc., can be regularly constructed from wood veneers. It is important in utilizing these materials to be familiar with their limitations and physical properties—with particular attention to the effects of impact, tension, temperature and moisture. Availability of the materials is satisfactory and they can readily compete with metal construction in present quantity production. The only question is whether there is enough tool and die capacity to meet present war requirements. The paper began with a definition of thermosetting which means infusible upon complete polymerization and thermoplastics which means materials that will soften and become plastic upon application of heat. Wood veneer materials were discussed and it was pointed out that the physical properties of these materials will in general vary almost directly with the density. Thus laboratory samples of material having 1.4 density have indicated tensile strengths as high as 50,000 lbs. per sq.in. Aside from ordinary strength characteristics, the most important factor is the effect of the operating temperature range. Increasing temperature decreases the strength of thermoplastic materials much more than thermosetting materials. In fact, from the author's discussion and charts it would appear that thermosetting materials could be used in aircraft (though not in the engine) without much regard to the temperature. On the other hand, with the thermoplastic materials a temperature of say 130°F. would reduce the strength to about 35 per cent of the standard strength at 77°F. Both thermosetting and thermoplastic materials are greatly inferior to aluminum alloy in impact strength but this does not indicate that they are inferior when used in properly selected and designed aircraft parts. Their lower impact strength is in most cases offset by their lower density which permits use of thicker section. The author was of the opinion that plastic parts could be designed for weight equivalent to that of its metal counterpart and no lighter. The problem of wear on plastic parts can usually be controlled through proper use of inserts. In deciding where to put inserts, the designer should take into account expected service life, type of wear involved, bearing stresses developed and type of lubrication to be supplied. When relatively large plastic parts are rigidly mounted to metal supporting structures, due account should be taken of differential coefficient and temperature expansion of the two materials. Thermosetting, thermoplastic and wood veneer materials all absorb moisture but to different degrees. With thermosetting and thermoplastic materials, moisture absorption may be neglected—not so with wood veneer materials, particularly when unimpregnated. The paper also discussed limitations of each type of material, tolerances and applicable specifications. A possible saving is estimated of some 40 million lbs. of aluminum if these materials were utilized in the following fashion: (1) Secondary structural and nonstructural applications; (2) transparent enclosures on internal parts; (3) sub-assemblies in wood veneer such as bomb bay doors, wing tips and the like.

Dealing mainly with plywood in aircraft construction was a paper entitled *Advances in Production and Assembly of Plywood in Aircraft Production* by Hugh G. Bersie and Edwin R. Clarke, Haskelite Manufacturing Company. This is a complete and scholarly plea for the use of plywood in aircraft. The authors sketch many changes that have occurred in the manufacture of aircraft veneers and plywood since the first great war. There have been many improvements in the coating of veneer and the drying of veneer. Visual inspection of veneer has given way to scientific testing. In the manu-

facture of plywood resin bonding has been perhaps the single greatest improvement. From blood and casein glue there has been a change to the mold-proof synthetic resins, first employed in liquid form and then as glue film which consists of thin paper carrying phenol formaldehyde resin of the thermosetting type. Plywood has been immensely improved in this respect, particularly in regard to protection against bacteria. The authors point out, however, that this is not the only improvement in the manufacture of plywood—that others have come in the selection of high strength veneer and in improved manufacture of plywood from veneer. There is one difficulty with plywood of the following character—when a structural engineer selects .08 in. 24ST for a spar, he knows exactly what he is getting, but when he selects 1/4 in. 5 ply yellow poplar plywood, he is confronted with lack of uniformity that exists in the manufacturing practices throughout most of the aircraft plywood industry. The lack of uniformity in specifications is a serious drawback. Heat presses are now used universally for plywood. Since the great war there has been improved design of aircraft using plywood and tooling has also advanced. The authors cite for example the use of steam heated hydraulic presses in production of aircraft panels—also electrically heated plywood presses using heating elements which permit gluing of six panels at one time. A dipping vat can be employed for moisture proofing of a complete wing. In general, the paper is one which deserves to be read with utmost attention by anyone interested in the utilization of plywood.

Alfred A. Gassner, Duramold Aircraft Corporation, discussed *Resin-Bonded Wood Laminates for Shell Type Aircraft Structures.* Wood veneer in combination with synthetic resins can be made impervious against atmospheric influences and in the form of laminations is well suited for construction of fully stressed shells for aircraft parts with comparatively few internal stiffeners. The author points out, however, that the design of such shells brings many new problems to the engineer since only little data exist on the allowable stresses for these materials. The behavior of each single lamination must be studied and new lines of structural thinking must be approached. The author discussed designs in which veneers of various thickness are laid out so that the grain direction of part of the layers crosses at right angles to that of the remainder of the layers—thereby the fact that the wood itself is not homogeneous is counteracted. If very many thin veneers are used, the highest possible homogeneity can be obtained. In this form of construction 10 to 12 plies are used in thickness of 1/4 in. Another advantage of the multi-ply construction is that because of the very thin veneer employed molding is possible to pronounced compound curved shapes. Many engineering problems, however, are involved in determining the stresses of the built up material from the properties of its component elements. Also, combined modulus of elasticity and Poisson's ratio offer mathematical difficulties. He is of the opinion that wood veneer base materials are the only type of material which can be used in molded panel form with a very small number of longitudinal stiffeners and gives one example where the stiffness of the skin is 13.9 times that of the aluminum alloy skin of the same weight. Therein lies a very strong argument for the utilization of plywood in stress skin type construction.

Arc Welding

Eric Dudley of the Buffalo Plant, Curtiss-Wright Corporation, in *Control Procedure of Torch Welding in Aircraft* did not discuss properties or appearance of welds but outlined control under which it may be expected that consistently sound welds can be produced. Production welders should understand basic metallurgy and the author endeavored to impart this information to the operator in simple language. He also gave definite tests for control, such as strength tests, visual examinations, bend tests, grading for appearance and warpage, etc. Questions of qualification tests for welders and similar problems and fine illustrations completed a paper which should be circulated in every aircraft shop in the country.

W. Stuart Evans, St. Louis Plant, Curtiss-Wright Corporation and V. V. Netchvolodoff, Hill Equipment Engineering Company, in a paper on *Flash Butt Welding of Chrome-Moly Steel* pointed out that flash butt welding has been an established industrial process for many years. The automobile industry in particular has used this process to take advantage of the low cost, high rate of production and excellent physical properties of the weld. Yet, strange to say, application of this process to chrome-molybdenum steels has been very limited—especially in the aircraft industry. Limiting factors have been lack of production volume, necessary equipment and experience. The process is represented in the schematic diagram of Fig. 2. In basic principle it is like that of the old method used by blacksmiths. In its simplest form the process consists of clamping two pieces of stock, as shown in Fig. 2, free from slippage, in current carrying dies, one of which is stationary and the other movable. A suitable mechanism moves the movable die in such a manner that the ends of the parts to be welded make contact. Current begins to pass between the two pieces upon contact and creates an arc. The mechanism continues to maintain the arc by steadily moving the pieces together as the edges are "flashed off." This phase is called the flashing period and sufficient heat

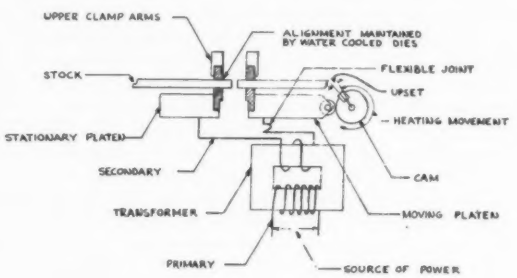

FIG. 2.

must be generated so that at the end of the flash period the steel immediately behind the molten surface is in a plastic condition. An upset action suddenly butts, or upsets, the two pieces of material in such a manner that the molten steel is extruded to the edges forming a rim or "flash." The equipment used may be manually operated or involve motor driven automatics or hydraulically operated automatics to provide appropriate pressures, clamps, temperature controls, etc. Aeronautical engineers should be primarily interested in this method of assembly because the strength of the weld is approximately equal to that of the parent metal and the weld structure is as resistant to fatigue failure as the weld joint produced by other methods. Some limitations exist in part design, but many standard structural items such as push-pull rods, engine mount lugs and tubing joint lend themselves readily to this method of fabrication. This paper gives a brief outline of the many variables involved in the process as well as part and die design. Only in recent years has any effort been made to determine the individual effect of the various factors involved with respect to aircraft steels. It should be remembered that this process as applied to chrome-moly steel is in the development stage and many of the procedures used at the present time may be discarded as a result of further research and additional experience.

Aluminum Alloys

Aluminum Alloys for Aircraft by T. L. Fritzlen, Reynolds Metals Company, is a textbook *in parvo* regarding the properties of aluminum and its alloys and covers the manufacture

of aluminum, its alloying chemical properties, use in aircraft parts, sheets, extrusions, etc.

Kirby F. Thornton, Aluminum Company of America, in discussing *Economic Advantages of Certain Aluminum Alloys for Aircraft Construction* does bring up an interesting idea whose logic the paper fully substantiates. Many aircraft parts, particularly fairings, cowlings, skin covering, etc., are often not intended to carry high stresses. Further, because of the necessity for a certain inherent stiffness or because of handling considerations, it is not always possible to use material as thin as would be permitted by considerations of design stresses alone. With these points in mind it is thought that considerable economic advantage can be gained by the more extensive use of certain lower strength, lower priced and more readily workable materials than the high strength aluminum alloys now generally employed. The aluminum alloys 53S, 61S and A51S possess the desirable characteristics of relative ease of fabrication, inherent resistance to corrosion, adaptability to spot welding and ease of forging when compared with such commonly employed structural alloys as 24S and 14S. Shop procedures may be employed which avoid troublesome distortion of parts as a result of quenching.

Inspection of Materials

Two of the remarkable advances in the inspection of materials lie in magnetic inspection and in X-ray inspection. F. L. Fuller, Ranger Aircraft Engines, presented a very fine study on *Effect of Magnetic Field Distribution in Magnetic Inspection.* This excellent paper cannot be better summarized than in the author's own words:

"This paper presents a study of the magnetic field distribution in an eccentrically cylindrical test specimen under various conditions of magnetic flaw inspection. Actual measurements of flux in the thin and thick sections of the specimen are presented which clearly show the existence of magnetic saturation in the thin section when large magnetizing currents are employed. This saturation results in high surface leakage and consequently very definite indications of flow line pattern. However, the thick section is unsaturated because of the choking action of the saturated section and no leakage or flow line pattern appears. A method is described for avoiding the saturation of this type of specimen and of producing substantially uniform magnetization with greater consistency of flaw indication. In addition, this device permits the use of lower magnetizing currents. The flux measurements are made by means of two search coils closely wound about the thin and thick sections. The flux is the time integral of the search coil voltage per turn. The two coil voltages are simultaneously impressed on the input terminals of two integrating, vacuum-tube amplifiers whose outputs are recorded by a two-element oscillograph. In this way, the actual flux pulses produced by one operation of the testing machine in the two sections are recorded simultaneously."

Instruments

As our aircraft obtain greater and greater speeds—particularly at high altitudes—a new problem arises which is defined by the name of the paper by W. C. Schoolfield of Vought-Sikorsky Aircraft Division, United Aircraft Corporation, *A Simple Method of Applying the Compressibility Correction Factor in Determination of True Airspeed.* There are in the airspeed indicator unfortunately too many errors—with position error as one of them, calibration error another one, and now compressibility. The ordinary airspeed indicator is based on the theory that compressibility may be neglected. Yet at very high altitudes the pitot tube is no longer immune to compressibility effects and the pressure differential becomes higher than that indicated by the ordinary Bernouilli equation and a plus error of 11 m.p.h. for a 400 m.p.h. airplane at 25,000 ft. altitude is encountered. The author develops a new method of computing the correction which is considerably less cumbersome than the previously suggested method and has the additional advantage of retaining use of the customary airspeed indicator acceleration chart.

It is interesting that a paper on x-ray inspection should come from a noted airplane designer, B. C. Boulton, Lockheed Aircraft Corporation, who discussed *X-Ray of Aircraft Castings.* During the past year constant concerted effort has been made by the Engineering Department of Lockheed Aircraft to build up effective control of X-ray inspection and to utilize in full the possibilities inherent in this type of inspection. We shall not deal here with the technique of radiographic inspection as developed by this Company nor with statistical results in the way of rejections, analysis of the nature of casting defects and similar technical matters, nor with the relationship established between X-ray film and strength tests. We do believe, however, that the conclusions arrived at may be of interest to all those interested in inspection of material—particularly in initial development work. Mr. Boulton's conclusions are as follows:

"(1) For certain important classes of material, X-ray inspection is a valuable tool. Its most important function is the creative one of aiding in the initial development of correct design, dies or patterns, and foundry technique. Its second basic function is that of maintaining a continuing control over foundry practice to insure maintenance of quality. It is not considered a suitable means for large-scale routine inspection where this is the only purpose served. An important exception to this last statement is the class of 'vital' structural parts with a low ratio of breaking load to design load, which may well be X-ray inspected 100% until further progress is made in foundry control.

"(2) Only by the setting up of comprehensive and carefully maintained routine controls can X-ray inspection be effective or economical. To secure proper value from X-ray inspection in maintaining quality standards, there must be a prompt follow-up on the information given by the control data. The cost of maintaining suitable controls, once they are correctly set up, is relatively small, even with large production. With the present knowledge of foundry technique and the type of equipment available in the better foundries making aircraft castings, a practically uniform, high quality product can be economically obtained if care is taken. It has been our experience that intelligent cooperation with foundries in the development of good castings is effective and well-received by the foundries.

"(3) X-ray inspection alone has only qualitative and comparative value in determining the structural airworthiness of parts with defects and should be interpreted by means of static tests on each specific part if rejections and the degree of radiographic inspection required are to be determined on an engineering rather than an arbitrary basis.

"(4) Defects which can be revealed by X-ray have a marked detrimental effect on the impact and fatigue properties of castings, much greater than the effect on static strength. With skilled and careful interpretation, there is a reasonably good correlation between these properties and the "quality" of a radiograph.

"(5) The standards for rejection by radiographic inspection should be based not on the absolute value of the casting quality, but on airworthiness considerations and should take cognizance of the ratio between the actual strength of a sound casting and its design load, and also whether the part is subject to unusual conditions of impact or fatigue. A definitely higher X-ray quality should be required for castings with minimum strength factors or those subject to definite impact or fatigue loading. Two or possibly three quality standards should be set up, and the individual having responsibility for rejection must know the quality standard applicable to each casting. Parts subject to impact and fatigue should meet a high quality standard."

The whole art of the anemometer is very old. Basic advances in it are rare. As pointed out in the paper *Guide Vanes for the Cup Anemometer* by Alexander Klemin and W.

C. Walling, New York University, the cup anemometer whether of the rotating or the stationary pressure type cannot indicate below a certain speed. If there were no frictional torque to overcome the instrument would be theoretically capable of indicating down to zero velocity.

It occurred some time ago to the first author of this paper that if suitable stationary guide vanes were provided for the cup anemometer, the velocity acting on the cups might be increased and the minimum velocity of indication might be reduced without recourse to the highly delicate and expensive design. The standard anemometer of commerce could then be made to give indications of lower velocity—an advantage in certain uses of the instrument.

A number of simple experiments were carried out in the four-foot wind tunnel of New York University with application of guide vanes to a conventional rotating cup anemometer. A definitely increased velocity acting on the cups has been obtained by the use of guide vanes and it was indicated that the stopping speed should be reduced about 50 per cent. However, it is reasonable to expect that even better results will develop through the use of a refined apparatus and by further research.

In a totally different category of instruments is *The Space Time Recorder* discussed by F. N. M. Brown, University of Notre Dame. In scholarly fashion the author goes into the history and merits and demerits of various types of space time recorders which are used in drop testing and landing gear shock absorber struts. If space time record is available, then velocities and accelerations should be deducible. After full examination, he comes to the conclusion that the best instrument is one of photographic character, which is superior to all other types. The first reason, and the most important one, is that a purely photographic recorder of distance versus time is not bound to any particular jig, installation or apparatus and may be used in any place and under any circumstances.

In a paper entitled *The Automatic Radio Compass* by Wilbur L. Webb and Gerald O. Essex, Bendix Radio Corporation Division of Bendix Aviation Corporation, the authors point out that the automatic radio compass is not limited to use in aircraft but can be used equally well on land or sea. The term automatic radio compass is employed by the authors as meaning equipment functioning in such a manner that an indicator automatically points to a radio transmitting antenna just as the needle of a magnetic compass seeks the north magnetic pole. The three types of radio equipment in use for obtaining radio bearings are described and circuits are indicated. Distortion of radio field is taken into account. Practical instructions are given as to the use and technique. Finally, much practical information is given to the pilot. The paper is scholarly and describes in splendid fashion what has been known generally but never presented so systematically. Yet perhaps the most interesting part of the paper is its latter portion which deals with a development not yet in production and is described as follows:

"One of the latest developments, not in production at present, is the combination of an automatic radio compass with a stabilized remote indicating magnetic compass. The two units are coupled to a common indicator. The remote reading compass is coupled to the azimuth scale of the radio bearing indicator, while the automatic radio compass actuates the pointer of the indicator. This combination affords a means of continuously and automatically indicating the bearing of a given radio station with respect to Magnetic North instead of the aircraft heading. Since magnetic radio bearings may be obtained directly from the indicator for any heading of the aircraft, the necessity of holding a pre-determined aircraft heading for position fixes is eliminated. The device may also be used for flying an infinite number of radial courses towards or away from a single radio station since there is only one line to the radio station having a given bearing with respect to Magnetic North."

Rotating Wing Aircraft

Interest in rotating wing aircraft has been sharply stimulated by government support and practical application. Perhaps one of the most interesting aspects of the meeting was the paper and moving picture presented by Igor Sikorsky under the title of *Recent Developments and Flights of the VS-300 Helicopter*. The pictures showed the remarkable control exercised on the Sikorsky helicopter, the performance of which is almost miraculous. While the general characteristics of the Sikorsky helicopter have been known for some time, it was strikingly brought forth by the speaker how control had been simplified. At first, it will be remembered, three auxiliary airscrews were employed—one to provide antitorque and two to give elevator and rolling moment control. Now control has been reduced to a single antitorque airscrew with lateral and longitudinal control both achieved by change of pitch. The thrust of the antitorque propeller, which also constitutes a rudder, is compensated for by slight tilting of the aircraft as a whole. Stability is reported as satisfactory though it is the general impression that the pilot has to exercise quite a good deal of control in hovering. The rotor remains of the flap type with feathering control both in pitch and laterally. The inclination of the helicopter in forward flight is of the order of minus 9°. Achievements of this helicopter are really remarkable.

Hitherto in papers on rotating wing aircraft it has been the tendency to deal with generalities rather than with detail design. R. H. Prewitt, Kellett Autogiro Corporation, has now presented in his paper *Rotor Blade Design* that type of detail study which is essential and helpful. His own abstract summarizes the paper in excellent fashion.

"The factors which affect the design of flexibly mounted rotor blades, that is blades incorporating horizontal and vertical hinges, are practically the same for autorotating rotors and power driven rotors in so far as knowledge of power driven rotors has progressed to date. The major difference between an autorotating rotor and a power driven rotor so far as the design of blades is concerned, is that in the former type there is a small flow up through the rotor, and in the latter case there is substantial downward flow through the rotor. Again, because of the relatively small flow up through the autorotating rotor, the blades may be built without twist and yet obtain optimum efficiency, while in the case of the power driven rotor, the blades will probably have a twist from root to tip similar to (but of less magnitude than) present engine propellers. Still another difference lies in the fact that owing to the continual power input in the case of the power driven rotor, there are decided variations in the root structure. Nevertheless the following paper, though mainly directed to the autorotating blade, is largely applicable to the power driven rotor. It deals with the general aerodynamics and design of the blade; with the bending moments; with blade weight estimates, and with typical blade construction. It is hoped that the brief treatment will be of interest to designers and others working in the rotary aircraft field."

Montgomery Knight, Georgia Institute of Technology, analyzes the helicopter in a paper entitled *General Flight Analysis of the Helicopter*. The flight path equation is obtained for the helicopter with thrust produced by tilting the rotor forward thus eliminating the conventional propeller. The flight path range from vertical ascent to the shallow power dive is covered. The basic assumption of the analysis is that the circulation about the rotor blades is independent of both radius and velocity. Since this assumption represents an ideal condition, the results are somewhat optimistic. However, the effect of varying the more important helicopter parameters can be determined with satisfactory accuracy. The simplicity of the method makes these determinations easy and rapid. Within the limits imposed by the assumptions adopted, the following conclusions were drawn from this analysis:

(1) The approximate flight characteristics of a helicopter can be obtained easily and rapidly.

(2) The effect of changing the power loading, solidity, blade profile drag and parasite drag can be determined with satisfactory accuracy.

(3) Extreme variations in both solidity and blade profile drag result in speed variations of less than ten per cent.

(4) Changes in power affect vertical climb velocity to a greater degree than climb velocity in inclined ascent.

(5) Variations in parasite drag produce large changes in level flight speed but have a negligible effect on vertical ascent.

(6) The power required for hovering flight is sufficient to produce appreciable rates of climb at moderate forward speeds.

(7) Minimum power for sustenation occurs at moderate forward speeds.

A discussion of autogiro stress analysis was given in a paper by Alexander Klemin, New York University, assisted by Wayne Wiesner, Kellett Autogiro Corporation, and W. C. Walling, New York University, under the title of *Rotor Bending Moments in Plane of Flapping*. The outline of the paper was as follows:

(1) Calculation of characteristics of a typical autogiro employed for illustrative purposes.

(2) Derivation of formulae for bending moments in the plane of flapping taking into account weight of blade, centrifugal force, inertia forces in flapping and aerodynamic thrust—mathematical methods substituted for empirical methods.

(3) Effect of azimuth angle Ψ on bending moments at a given point on the blade.

(4) Effect of variations in μ.

(5) Effect of variation in μ/R at varying values of μ.

(6) Derivation of formulae for centrifugal relief.

(7) Comparison with empirical methods.

The conclusions were:

It has been shown that in an autogiro rotor of constant chord and blade setting:

(1) The range between the maximum positive and maximum negative bending moments increases with the value of μ.

(2) The maximum bending moments are likely to occur where $r/R = .4$ or a little over.

(3) The maximum negative bending moment occurs when $\Psi = 120°$ and the maximum positive bending moment when $\Psi = 300°$.

(4) The method based on aerodynamic investigation is in fair agreement with Mulvey's formula as far as the moments of the rigid blade are concerned.

(5) The formulae for the relief of bending moments by centrifugal force present relief of the same order of magnitude, but the relief factors are not in as close agreement as the moments for the rigid blade.

It is believed that the methods presented in this paper place the subject on a better basis than the purely empirical formulae generally employed, and that the following further research is desirable to extension of the methods to tapered autogiro blades, application of the method to helicopter blades, a closer examination of the problem of centrifugal relief.

Air Transport

In the Air Transport session some interesting papers were presented. C. G. Peterson, Railway Express Agency, discussed *Air Express and Freight, The Past, Present, and Future*. The paper presented complete statistics on revenues, rates, loads, amount of business in almost encyclopedic fashion. The question is often asked—what is the weight per cu.ft. of air cargo? A careful survey indicates that the average is 1.3 lbs. per cu.ft. but millinery averages only 2.7 lbs. per cu.ft. and cut flowers 4.9 lbs. per cu.ft. Interesting suggestions are made in regard to the design of cargo airplanes. Protection to the lading from extremes of temperature should be made, particularly for such things as cut flowers and fresh vegetables. Ventilating requirements for air cargo should not be troublesome though in aerial express service baby chicks move in tremendous quantities and require plenty of fresh air. Pressurizing of cabins does not seem necessary. Doors 6 ft. × 6 ft. would probably be satisfactory. Cargo doors might be installed on either side of the airplane. Looking at the future the following is an interesting forecast:

"It is too soon after December 7, 1941 to know what the general effect of war conditions will be on the volume of common carrier Air Express and Freight. But, putting aside war conditions, I had previously estimated that the normal growth of Air Express and Freight at approximately present rates and service would, in the calendar year 1946, produce 3,732,140 shipments weighing 18,500 tons with a gross revenue of about $13,000,000, providing the postal charges for air mail remained constant and that the airlines would probably reduce long-haul express rates, continue to introduce commodity rates, and maintain substantial minimum charges. The 18,500 tons forecast for 1946 is 332 per cent of the tonnage estimated for 1941."

Mr. Peterson presents strong arguments for a consolidated agency to handle cargo and express work of the companies.

Charles P. Graddick, United Air Lines, wrote on *Operating Requirements for Air Cargo Transportation* and defined many things necessary in the future if air cargo is to grow. Airport facilities must be increased, speed of handling and suitable warehousing must be provided as well as speedy loading accessories. Rates must come down to determine volume. All cargo planes must be carefully studied afresh. Flying personnel will still require the usual pilot and co-pilot and perhaps a cargo handler on board. Pick-up and delivery service must be considered.

A. E. Blomquist, Eastern Air Lines, presented a paper on *Economic Effects of Airport Size and Airway Deficiencies*. The author is very strongly of the opinion that instrument landing systems are now available for practical use or can be readily made available and there is no excuse for not immediately installing such systems. Airway congestion is already a serious problem. He points out in conclusion that the airliners of this country make over 500,000 landings and take-offs a year. There has come a time when redesign of transport fields has to be seriously considered. Length of runways, position of taxiways and other factors now cause excessive wear and tear on flying equipment. In the design of taxiways runway lengths are too little and when a transport plane lands it rolls past the turn offpoint on the landing runway or must be sharply braked to slow the plane in time for turn off. When a plane over-rolls a taxiway, the pilot must come to a sharp stop by alternate applications of power and severe braking, turning the plane through 180°, with consequent wear on the rubber of the wheel. The average taxiway or runway intersection has rather short radii of turns in addition to poor location. There are many other deficiencies for which the author suggests a remedy.

Meteorology

The meteorological sessions were held in cooperation with the American Meteorological Society. No preprints were available for this session other than the paper on *Guide Vanes for the Cup Anemometer*, already reviewed under the heading "Instruments."

Physiologic Problems

As these papers were presented in a confidential status, no preprints of them were available.

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Aviation industry

WE PUT OUR HEADS IN THE CLOUDS AND MADE RAINDROPS TO ORDER

YES, we had to put our heads up into the overcast to figure this one out.

We wanted to know exactly where icing raindrops fall on a plane's wings while it's in flight. We wanted to know how different rates of speed, different wing sections, and different sizes of raindrops affected this pattern.

This problem led to some very interesting and very exhaustive raindrop research, conducted with the cooperation of Daniel Guggenheim Airship Institute, Akron, Ohio. First, we poked our heads into clouds . . . took them apart—assembled facts on raindrop sizes. Then we had constructed models of various airplane wings.

We fixed one of these wing-sections onto an arm in a housing specially built so that we could whirl the section at controllable speeds. Next we cemented sensitized paper onto the leading edge of this wing. Then we started things whirling.

At a fixed point in the rotation, we released raindrops of one specific size. Then we removed the sensitized paper and counted the raindrops, plotting their position in relation to the leading edge of the wing. We did this over and over again . . . at different speeds, with different size raindrops . . . with wings tipped at angles, with wings presenting different airfoil surfaces.

We have graphs that tell where freezing rain hits a wing . . . that tell us just how far back from the leading edge of a wing De-Icers should extend for adequate protection.

We have a catalog available to you containing technical data on De-Icers. We hope you'll feel free to call on us at any time with ice elimination problems or with any others in which our research might prove of value. Write, air-mail, to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

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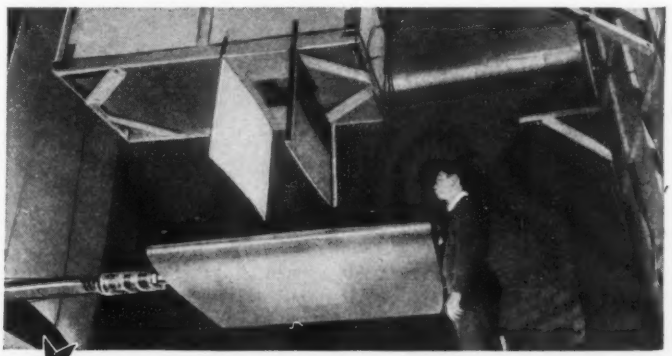
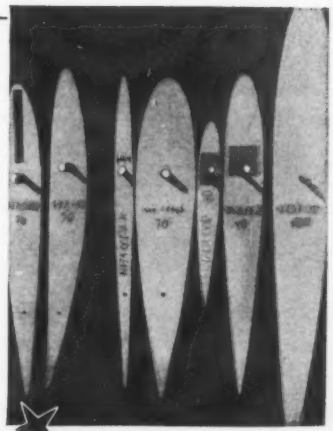
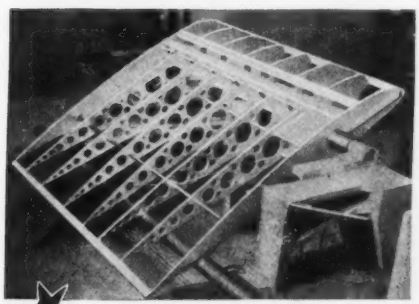
Tests on the basic conditions for ICE FORMATIONS



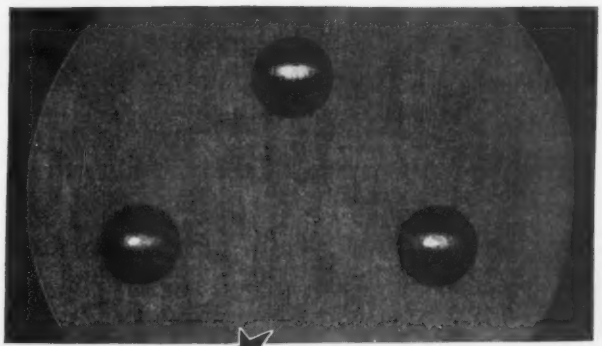
Original test set-up with the 70" x 70" NACA-0012 airfoil attached to the end of the whirling arm.



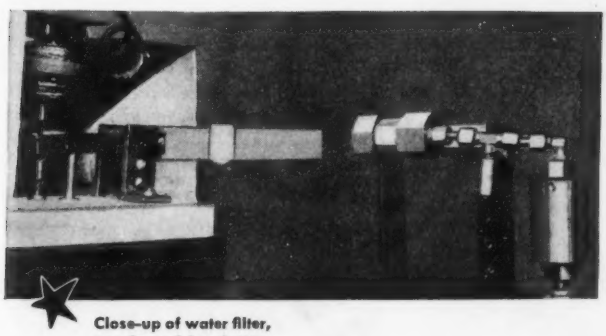
Airfoils tested.



Framework for the 70" span and 70" chord NACA-23012 airfoil test model with slot.



A portion of the paraffin plate showing three droplets of approximately 0.30 diameter.



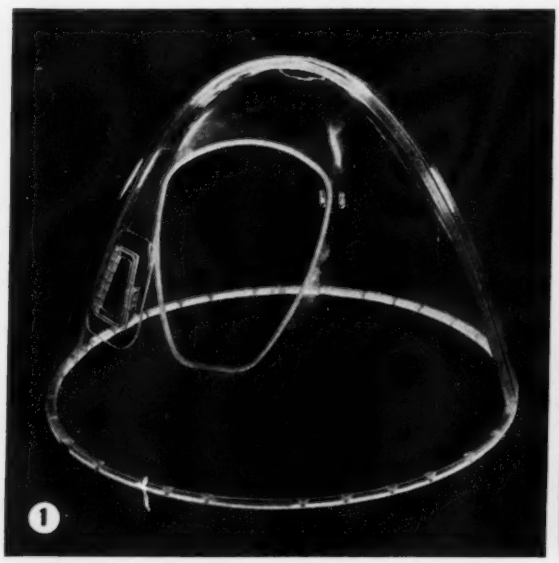
Close-up of water filter, nozzle and jet shutter.

Fly with BF Goodrich
FIRST IN RUBBER

Martin Developments in Plastics do More than Save Aluminum

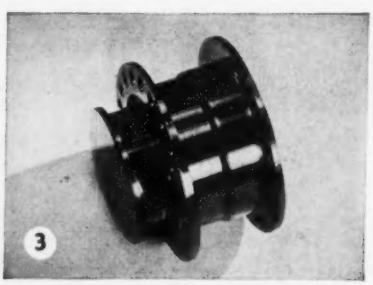
MORE than 400 plastic parts, developed by Martin engineers, now replace aluminum in one Martin Bomber. Included are radio masts, equipment supports and housings, control quadrants, brackets and many other small structural parts made from thermosetting materials . . . bomber noses, gun turrets and windshields made from thermoplastic materials . . . bomb bay doors, wing flaps, wing tips, table tops, cabinets and other larger aircraft assemblies made from veneer materials.

Pictured here are a few of these developments which, in addition to saving aluminum, machining operations and assembly time, reduce the weight and increase the efficiency of Martin Bombers for our fighting forces.

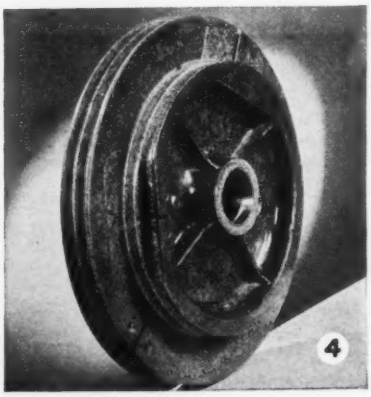


1. ***All Plastic Nose*** of the U. S. Army's Martin B-26 . . . made from tough, clear acrylic sheet. The first *all*-plastic nose section . . . made without metal supporting members which hamper visibility. Less than half the weight of glass; quickly formed and easily worked; affords high resistance to sun, weather and high air pressure.

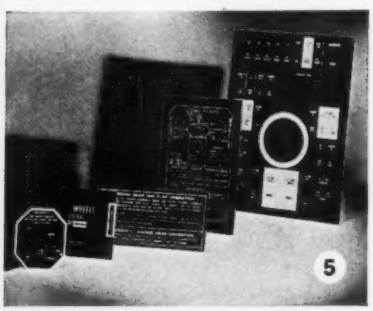
2. ***Radio Antenna Mast,*** smooth surface of which lessens aerodynamic drag. Base, mast and cap are all of molded-macerated or molded-laminated phenolic compounds. 'Advantages lie in lightness, bending strength, economy in production, and high dielectric qualties. Structurally efficient, easily manufactured and installed.



3. ***Cabin Ventilator*** of phenolic plastic, eliminates corrosion problems. Its intricate shape, which would require much machining in metal, is easily molded from plastic. Neat in appearance, light in weight, plastic ventilators are well suited to quantity production. Adaptable for both military and commercial aircraft.



4. ***Control Quadrant,*** connecting pilot's controls with aileron cables . . . made from macerated fabric-filled phenol-formaldehyde molding materials. Withstands wide variations in operating temperatures. Test of 20,000 cycles continuous operation under load showed no undue wear in grooves. 20% lighter than cast aluminum, requires far less machining.



5. ***Pilot's Switch Panel*** of laminated thermoset plastic—with markings on panel in fluorescent materials activated by ultraviolet light. Clearly visible to the pilot—lessens danger of detection. Transparent plastic sheets cover panel to protect fluorescent materials and prevent rubbing off or obscuring of fluorescence.

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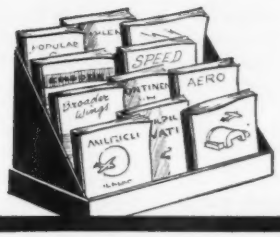

Periodicals

Accessories

Aircraft Electrical Wiring. Part I. The first in this series of articles outlines the features and principles of the Breeze method of electrical wiring and stresses the importance of a sectional system for modern aircraft. It describes the expediencies of replacing the point to point type of operation with an installation of branching conduit systems and how the Breeze method conforms to the following conditions: speedy installation, sectionalization, simplicity of isolation for testing purposes, complete designation in following out circuits for fault location, ease in replacing sections of wiring, and suitability for mass production. *Aircraft Production*, January 1942, pages 119, 120, 1 illus.

Aircraft Electrical Wiring. Part II. Continuation of an analysis of the method is made in this second article on the Breeze System. Inspection and testing procedure are discussed along with the main features of this electrical wiring system in relation to aircraft. *Aircraft Production*, February 1942, pages 187–189, 5 illustrations.

Superchargers. W. v. d. Null and H. Pfau. Translation of an article by two German specialists published in the *ZVDI* of September 20, 1941. The evolution of superchargers, their design and construction, is reviewed. Blower is compared with other types. Blower requirements are outlined with information to substantiate the writers' contention that the centrifugal type is superior. Aerodynamic supercharging, rotor materials, bearings, volumetric efficiency and blower efficiency are discussed at length. Details are given on various blower experiments. *Flight*, January 15, 1942, pages 52–54, 6 illus.; January 22, 1942, pages 70h, 71–75, 2 illus.

Landing Gear for Fighting Planes. Jule Bemb. A detailed description of the machine layout for flow-line production of landing gear parts and components on a gravity roller-conveyor assembly line. Machining methods and processes are outlined with dimensions and tolerances used for each of the component parts. Successive steps in the manufacture and assembly of the entire landing gear from the raw material to the finished unit are traced. Numerous photographs show the working stages in machining and inspecting the parts. Drawings are reproduced with detailed measurements. *American Machinist*, February 19, 1942, pages 115–126, 18 illus.

Directory of Aviation Suppliers. An alphabetical listing of the suppliers of aircraft parts, equipment, products and services in the United States, this annual directory is set up under 120 classifications representing the products or services. *Aviation*, February 1942, pages 225, 226, 230; 233, 235, 236, 239, 240, 243, 244, 247, 248, 250, 253, 254, 256, 258, 260, 262, 264, 266, 269, 270, 272, 274, 276.

Electrical Power in Aircraft. George W. Ledbetter. With the increase of auxiliary power requirements in modern aircraft, manufacturers have used a combination of electrical and hydraulic power to meet these needs and a few have used electrical power entirely, with the penalty of greater weight. This article describes a number of changes which have taken place and are now evolving in the field of aircraft electrical power. The possible effect of these changes on future auxiliary power applications is prognosticated.

In general, present electrical systems employ equipment which is increasingly light and more dependable. They are becoming less susceptible to damage by gunfire and their characteristics of cleanness, operation unaffected by high altitudes and low temperatures, and speed of replacement improve the suitability to the growing auxiliary power needs in the modern airplane. *Aero Digest*, February 1942, pages 163, 164, 166, 169, 170, 8 illus.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Review or the Institute of the Aeronautical Sciences.

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Air Policy

Aviation Planning. Navator. While the most important task that aviation has at present is to help win the war, this article points out that some plans must be made for the period following the conflict. Handling the British problem from a universal basis, the article divides the problem into three eras; the prepeace era, the interim post-war era and the ultimate peace era.

In these periods, the machinery for peace must be set up, using the facilities of existent organizations such as the Royal Aeronautical Society, the Society of British Aircraft Constructors and similar organizations and applying them to the problem of reconstructing the industry for peacetime operation, so that the reshuffled and rebuilt organization will be capable of coping with the task it must ultimately face. Methods for arriving at this goal are suggested. *Aeronautics*, January 1942, pages 48, 49.

An Obligation for the Future. Alexander Kartveli. Keynoting the significance of the developments of wartime aviation to the future of civil aviation, the vice-president of Republic Aviation Corp. indicates that even now many fundamental improvements are being achieved which will have a vast bearing on the growth of civil aviation generally after the war. Among the improvements are aerodynamics of design, structural design, efficiency and performance of both aircraft and engines.

Positive results of the war predicted by the writer are the immediate development of postwar types faster than any now existent; the opening of a vast field in air cargo; the acceleration of private flying due to the lowering of cost as a result of improved manufacturing methods and growth; and more economical production. It is concluded that it is up to the industry to build its own future by utilizing the tremendous amount of knowledge and experience being gained today. *Aero Digest*, February 1942, pages 124, 125, 268, 1 illus.

Groundwork. A story of the extensive work performed in providing modifications to and new equipment for the miscellaneous additions to the British Overseas Airways Corporation's growing fleet and its existing fleet. *The Aeroplane*, December 26, 1941, page 717, 1 illus.

The Airlines and the Future. Frank L. Stebbins. A general survey of the position of American airlines with regard to future development, this article indicates the effect of increased defense travel in promoting ultimate solution of the fast growing need for expansion of airway routes and facilities. The problem of airmail revenues is discussed with the conclusion that it "will continue to make the carriers dependent financially upon the Government for some time to come."

The belief is expressed that the air carriers will probably continue to function as private enterprises, despite extensive military demand on airline facilities and despite the powers incumbent in the Secretary of War for taking possession and assuming control of any civil aviation system. *Flying and Popular Aviation*, March 1942, pages 32–34, 94, 2 illus.

China's Burgerluchtvaart (China's Civil Aviation). W. Van Beek. Since Japan invaded China, air travel via China National Aviation Company is somewhat hazardous. The K.L.M. still accepts bookings to China, but the passengers change to a Chinese plane at Rangoon for either Hongkong or Chungking, the new Chinese capital. Before the invasion, the German air line, "Eurasia," maintained a well scheduled service from Hongkong to the inland.

The C.N.A.C. operates not only with American capital but also with American pilots and ground crews; in fact it is an entirely American organization which may become of great importance when the P.A.A. service to Hongkong is reopened. Before the invasion, this company had 19 airplanes and a personnel of about 150. Its network comprised about 4,500 kilometers. However the company is up against great difficulties on account of the war. Several routes had to be discontinued because the Japs shot down some of its transport planes. Therefore flights are made during bad weather and at night, without any schedule.

In a review of the development of the C.N.A.C., the writer states that in the beginning they had small Loening Air Yachts which covered the route Shanghai-Hankow, a distance of about 700 kilometers. Gradually other large cities were included in the service which added the routes Shanghai-Tientsin-Peking, Shanghai-Nanking-Chengtu, Hankow-Chungking, Shanghai-Hongkong, Shanghai-Canton, etc. Modern Douglas and Sikorsky planes were put in use on these routes. *Luchtvaart*, December 16, 1941, pages 460–464.

Directory of United States Airlines. An alphabetical listing of the personnel and officers of airlines operated in the United States. *Aviation*, February 1942, pages 221, 222.

Air Transport

Om de Hegemonie Boven den Atlantischen Oceaan (For the Hegemony Above the Atlantic Ocean). Referring to brief notes on this subject previously appearing in this magazine, this article reviews the situation after the U.S. Senate had voted a yearly subsidy of $1,229,000 to the American Export Airlines for mail service between the United States and Europe. The writer suggests this act as unusual because the company has no established routes.

Juan Trippe, president of Pan American Airways, is quoted as saying that there is no room for two companies to compete in the transatlantic air service, as only one company could render it profitable. The writer notes the rumor that President Roosevelt might intervene, leaving P.A.A. with the route it already has established and giving American Export Airlines a new route to Foyne, Ireland. *Vliegwereld*, November 13, 1941, pages 654, 655, 4 illus.

Airplane Descriptions

Curtains for Stringbags. Fougueux. An appraisal of the effective work of the Fairey Swordfish. Describing some of the characteristics of this torpedo spotter reconnaissance aircraft type, discussion is given to its specific merits in various types of air war operations. *The Aeroplane*, January 16, 1942, pages 68, 69, 3 illus.

Another Wing. John P. Davies. A description of the Manta, projected long-range fighter utilizing the patented Davis wing in a manner which produces a much different contour from that of the Consolidated B-24 with a leading edge 30 inches thick at the root. *Western Flying*, February 1942, pages 29, 60, 3 illus.

U.S.S.R.—New Airplane Types. A résumé, offered in the absence of official information, on the types of aircraft now being used by the Soviet Air Forces. Besides the widely publicized *Chato* I-15 and *Rata* I-16, the air-cooled monoplane and biplane types which were used in the Spanish War, modifications of the I-16 with altered power plants and armament are described along with the newer types, such as the I-17, 18 and 19 series, which showed the influence of the Spitfire in their general lines. Other aircraft accounted for are the R-6, SB-1, DB-4 and the Stormavik, all of which have been mentioned in recent Russian dispatches. *Interavia*, September 8, 1941, pages 8–11, 6 illus.

German Aeroplanes in Service. XIX–XXIII. Continued weekly columns containing drawings and descriptions of the types of German aircraft now in service. Intended as a useful guide to German aeronautical design, the column presents available data on the type, crew, armament, dimensions, weights and performance of each airplane. *The Aeroplane*, December 26, 1941, page 714, 6 illus.; January 2, 1942, page 21, 6 illus.; January 9, 1942, page 51, 6 illus.; January 16, 1942, page 77, 5 illus.; January 23, 1942, page 110, 6 illus.

Aviation Directory. Photographs and descriptive data on American civil aircraft types grouped under the 1–3, 4–5, and 6-place classifications. Information contained in this annual presentation by *Aviation* includes dimensions, specifications, performance and construction material in so far as made available by manufacturers. Three-way drawings of most of the airplanes presented are also included.

An addition, this section provides photographs, three-way drawings and as much data on current American military airplanes as is available. *Aviation*, February 1942, pages 135–138, 141, 142, 145, 146, 151, 152, 155, 156, 159–162, 165, 166, 169, 170, 173, 174, 177, 178, 181–183, 191 illus.

Military Aircraft Specifications. Military data, in so far as released, is given on the power plant, performance, weights, dimensions, area, landing gear and structural material of military aircraft produced in the United States. *Aviation*, February 1942, pages 207, 208.

Civil Aircraft Specifications. Tabular data are given on the power plant, performance, weights, dimensions, area, landing gear and structural material of civil aircraft produced in the United States. *Aviation*, February 1942, pages 203–206.

Foreign Airplane Specifications. Tabular data, in so far as available, are given on the power plant, performance, weights, dimensions, area, landing gear and structural material of foreign, civil and military airplanes. *Aviation*, February 1942, pages 209–212.

Airports

The Development of Aircraft Hangars. L. B. Dyball. A consideration of the problems involved in hangar design and construction in the light of developments during and since the World War. The article indicates that the present major considerations are the size of the airplanes to be housed and the peculiar conditions created by the present war.

Other influences are the auxiliary functions that the hanger must perform such as shop and living facilities, materials available, cost, etc. Various types of building and door construction, layout, sheltering plans and the like are presented, particularly in the light of British wartime hangarage problems. *Aeronautics*, January 1942, pages 58–61, 8 illus.

Wilderness Warpath. James Montagnes. An account of the immense construction program undertaken by Canada in the building of an airway through the western Canadian wilderness, north to Alaska. The problems of transporting necessary construction equipment to interior points and of turning back-country sites into modern airports are described. A map shows the route of the airway being built and air and mail lines, as well as the paths of tractor trains which transported equipment inland to airport sites. *Western Flying*, February 1942, pages 24, 25, 59, 7 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Armament

Hit or Miss. W. E. Hick. In order to increase the deadliness of the fighter airplane, the tendency is to increase its fire-power by such expedients as increasing the number and weight of the guns, stepping up firing speed, etc. This results frequently in the sacrifice of ammunition capacity and fire sustenance. The compensating factor is the human side of the air-battle equation, increased fire accuracy being achieved through superior marksmanship.

The writer, pointing out that hunting an airplane with a single directional weapon is like hunting ducks with a rifle, discusses the diffused or shot-gun action of the multiple-gun armament of the modern fighter, and indicates the mathematical ratio between possible human and mechanical error which finally makes the end result of fire effectiveness. *Aeronautics*, January 1942, 32–34, 5 illus.

Winged Rocket Bombs. Zbigniew Krzywoblocki. A discussion of bombs propelled by rocket power, as proposed by the French aerial strategist, Rougeron. The theory of the construction of such bombs is outlined and method of propulsion and launching are described. The potential effect of this weapon on the conduct of modern warfare is noted. *Astronautics*, December 1942, pages 7–9, 1 illus.

Growth of Fire Power in Navy Planes. Joy Bright Hancock and Earl Burton. Noting that the progress of fire power and evolution of the airplane as a fighting instrument are quite as influential as the development of the airplane, this article defines fire power as "the quantity of metal that can be projected at a target at a given time interval." The development of fire power from the beginnings of airplane activity in the first World War is reviewed and brought up to date with an explanation of the arrangement and combinations of fire power equipment on contemporary military airplanes. *Aero Digest*, February 1942, pages 70, 71, 271, 272, 9 illus.

Kanonnen op Vleugels (Cannons on Wings). A review of the development of the armament of military airplanes since the first World War. While at that time only machine guns were used, modern military airplanes carry one or more cannons, besides an augmented number of machine guns to increase the fire power. Cannons and their ammunition are described as used by the various air forces, with special reference to the Madsen 23 mm. gun and the American Armament Corp. 37 mm. cannon. *Vliegwereld*, November 13, 1941, pages 650, 652, 5 illus.

Firepower. Donald G. Smith. An armament engineer gives a general discussion of this phase of aeronautical design, showing the sometimes decisive effect of firepower needs on airplane design. Reference is made to current military airplane types illustrative of the influence of firepower requirements. *Flying and Popular Aviation*, March 1942, pages 45, 46, 90, 92, 94, 3 illus.

Avigation

The Stars This February. Warren C. Youngclaus. A general explanation of the position of the stars during the month of February as relates to flight navigation by the stars during this month. *Aero Digest*, February 1942, pages 64, 273, 274, 2 illus.

A New Instrument for Celestial Navigation. N. Wyman Storer. An instrument is described in which a pair of mirrors and a prism deflect the light of two particular stars into a telescope in such a manner that when the images of the two are seen superposed in the center of the field of view the telescope axis must be pointing directly at the celestial pole. Its angular elevation is then equivalent to the latitude, and the rotational position of the mirror combination about the telescope axis shows the sidereal time. The direction of gravity may be indicated either by a bubble cell or by a pendulum stabilized in some manner. A preliminary model, making use of a bubble, has given a probable error of one setting of about 0°.1 in

both latitude and longitude, successive readings being separated by less than two minutes of time. *Journal of the Aeronautical Sciences*, February 1942, pages 138–140, 2 illus.

Business and Finance

Looking Ahead in Aviation. Underwriting-I. Winthrop A. Hamlin. First half of a two-part attempt to prognosticate aircraft developments affecting insurance. *The Spectator*, February 1942, pages 10–13, 24.

"Aero." E. Jay Doherty. An account of the unique aspects involved in underwriting insurance on airplanes is given in this article on the activities of Aero Insurance Underwriters. The progress made in this type of insurance business is noted in an explanation of the part played by this company in promoting safer flying and in working toward lower insurance rates. *Flying and Popular Aviation*, March 1942, pages 30, 31, 96, 98, 4 illus.

Aviation in a War Economy. Selig Altschul. Summarizing the status of military airplane production and civil aviation operations in the United States today, this financial writer indicates the current position of aviation finance and describes the adaptation of the industry to the demands and exigencies of wartime economy. *Aviation*, February 1942, pages 131, 133.

Civil Air Defense

Civil Air Patrol Units. Charles B. Ripley. A group of suggestions are offered by Aero Insurance Underwriters in this article for those pilots in many communities who would set up local units of the Civil Air Patrol which could be used for any number of duties by the military services or other Government agencies. Information is given on how to organize a local unit, on the qualifications necessary in flight personnel, on how to select a suitable airport, on how to obtain C.A.P. approval and on the kind of ground training desirable. *Aero Digest*, February 1942, pages 76, 268, 2 illus.

The Backbone of Aerial Defense. Statistics on civil aviation in the United States in the year 1941 are graphically presented in the form of data on the safety record, air travel, private flying operations, airport expenditures, airplane production and export, and airmail and flight revenues. *Aviation*, pages 86, 87, 6 illus.

To Be or Not to Be! George E. Haddaway. A brief review of the status of civil aviation as now organized in the form of the Civil Air Patrol, "a direct-action organization now marshaling every civil airman and resource for use in America's war effort." The structure of the C.A.P. as an outlet for private pilots anxious to contribute to the defense effort is outlined. The civil airman's place in this organization is particularly emphasized. *Southern Flight*, January 1942, pages 16–18, 3 illus.

The Auxiliary Air Arm. Clinton B. F. Macauley. The Civil Air Patrol is organized on a national basis to use systematically in the total war effort the great reservoir of manpower, planes and ground equipment represented by civil aviation in the United States. This article affords a clear explanation of the Civil Air Patrol's origin and objectives, its organization and composition. A brief summary is given of the status of civil flying under the C.A.P. *Aviation*, February 1942, pages 82, 83, 319, 320, 323, 5 illus.

Civil Aviation

Flivver Flying Through Central and South America. Charles F. Berry. This is an account of a 12,000-mile vacation flight by two California dentists in a 75-hp. Continental-powered Culver light airplane. They

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visited 18 nations at a total flying cost of $300, pioneering a type of air touring that should become common after the war and should do much toward cementing the ties among the countries of this hemisphere. *The Sportsman Pilot*, February 15, 1942, pages 10–11, 6 illus.

Wartime Developments of British Airways. An account of the work being done by the British Overseas Airways Corporation to maintain efficient services and to continue improvement of facilities and equipment despite wartime exigencies. New aircraft, including the Curtiss-Wright CW-20 Transport, and wartime maintenance methods are described.

Among the equipment being provided on overseas transports are life-saving apparatus and rubber dinghies fitted up for emergency out at sea. Machine tools and fittings as well as maintenance methods have been reorganized to cope with innovations resulting from the placement in service of American aircraft.

The CW-20 is described at length and the conversion of military aircraft, such as the Consolidated Liberator, to use for transport purposes is described in some detail. *Modern Transport*, December 27, 1941, pages 11, 12, 3 illus.; January 3, 1942, page 7, 3 illus.

Ten Years of Civil Air Expansion to January 1, 1942. Tabular statistics are presented on the growth of civil aeronautics in the United States during the past ten years. *Aviation*, February 1942, pages 88, 89.

Plane Planters. S. R. Winters. A description of seed-planting from airplanes as a means of overcoming the inaccessibility of mountain ranges in the reclaiming of grazing lands for roaming herds of cattle. *Flying and Popular Aviation*, March 1942, pages 48, 49, 113, 4 illus.

War Refugees. William Flynn. The plight of private, training and other non-scheduled operators in the defense areas of the West Coast is presented in this article. It indicates the manner in which vague administration of restrictions has virtually grounded private operators, limited the radius of action of flying schools, and generally restrained one-line aircraft in this area, to the extent that many pilots whose services might be valuable in some capacity in the near future must permit licenses to lapse for lack of flying opportunities. *Air Facts*, February 1942, pages 10–16.

Grin and Bear It! Robert H. Hinckley. In this message from the Assistant Secretary of Commerce for Air, readers are reminded that non-scheduled aviation and other civilian air activities, like everything else, must be adjusted to war conditions. However, private aviation through the Civil Air Patrol, the Civilian Pilot Training Program and other activities continues to contribute to a speedy and complete victory in the war.

The writer indicates that several types of non-scheduled commercial flying will continue in volume, as well as the numerous branches of non-combat military aviation. Looking forward to the resumption of the nation's normal way of life after the war, he predicts greatly extended airlines, air cargo services, increased air mail, more and better airports and airways, and an industry so skilled in mass production that it will turn out family-type "air-flivvers" offering safety and simplicity of operation at motor car prices. *The Sportsman Pilot*, February 15, 1942, pages 8–9, 1 illus.

Design

German Aircraft Developments. Noting the German announcements implying that the deaths of Generals Wilbert and Udet and Colonels Moelders and Von Werra resulted during test of important new aviation developments, this editorial indicates that these implications are to be taken seriously and suggests what some of these developments may be.

It is said that the Germans are pressing forward frantically and desperately with new types of aircraft, some of them of revolutionary design, such as heavily laden bombers, the take-off of which will be assisted by rocket propulsion. It is also suggested that the Germans will make strenuous efforts to produce aircraft of outstandingly improved performance and new operational characteristics. *The Engineer*, December 5, 1941, pages 394, 395.

Standardised Controls. Standardization of main flying controls is the objective of the Saunders control system, described in this article. Comprising tubular push-pull control rods to which a rotary movement may also be imparted, this arrangement can be used to operate two surfaces separately or simultaneously without interference between the two elements. Typical applications on larger aircraft are the aileron or rudder and their trimming tabs. Preliminary to the discussion of this new British system is a brief account of the German Junkers methods. *Aircraft Production*, February 1942, pages 192–194, 9 illustrations.

Appendectomy. Roger Tennant. Further comments by Roger Tennant on his opposition to the "tailless" type of airplane design. These observations are followed by further editorial opinion. The additional notes by the writer may be summarized:

"That the 'all-wing' airplane cannot be realized in practice because at present-day wing loadings there is insufficient space in the wing to accommodate the load.

"That as a fuselage is therefore necessary, it is more sensible to put the elevators and rudder on the fuselage, where they are efficient, than on the tips or trailing edge of the wing, where they cannot have so much power unless the tips are swept back until they are as far distant from the center of gravity as the tail of a conventional airplane, which is obviously impracticable.

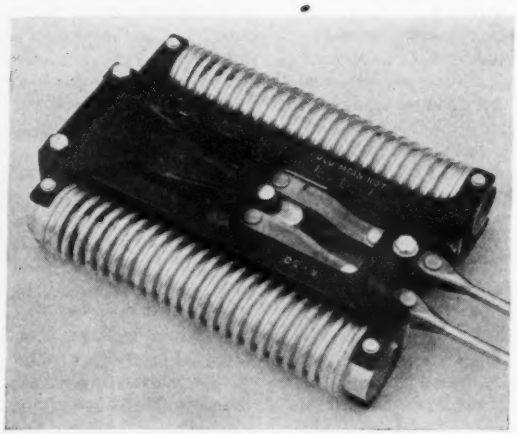
"That to employ high lift flaps requires 'auxiliary aerofoil' to compensate the shift in the center of pressure."

The editorial answer discusses in detail the above points from the opposing point of view and refuting the propositions set forth by the opponent of the "tailless" design. *The Aeroplane*, January 2, 1942, pages 10, 11, 5 illus.

Twin Tail Booms. A brief review of the evolution of twin tail booms in aeronautical design and an explanation of their function. The modern application of twin tail booms is said to be due to operational rather than aerodynamic considerations since on small civil types of aircraft they avoid the very high drag of the open tail girder of the earliest aircraft. Experimental development in plain twin-engine, twin-fuselage design without a central nacelle is noted, although this type of aircraft has not come into use. *Flight*, January 15, 1942, pages 48–50, 7 illus.

Planes of the Future. A general description of some of the new airplane designs which have undergone study and experiment by Air Corps engineers at Wright Field in recent years. *Western Flying*, February 1942, pages 44–46, 48, 7 illus.

Aviation Sketch Book of Design Detail. A number of perspective drawings and cutaway sketches are presented showing structural and design details on landing gears, fuselages, armament and airplane subassemblies of such airplane types as the Bell Airacobra, the Morrow trainer, the Douglas DC-4, the Aga (formerly Pitcairn-Larsen), the Cessna-T-50, the Ryan ST-3, the Morton



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All's Well That Lands Well. Gordon Sear Williams. Stating that getting airplanes on and off the ground has always been a problem for aeronautical engineers, the writer traces the development of landing gears from the simple skid devices used by the Wrights and Curtiss to the latest retractable landing mechanisms. Photographs show many of the early attempts at the solution of these problems, including numerous styles of shields for reducing wind resistance. *Air News*, January 1942, pages 26–33, 47 illus.

But Will It Fly? To give a hint as to what may lie ahead in the development of new types of aircraft, this article presents drawings and photographs of several unorthodox airplanes. Some of these have already been flown and the writer states that others may never leave the ground. Two of the illustrations show imaginative conceptions by artists and the others are actual inventions, some patented, intended for the transport and combat fields. *Air News*, January 1942, pages 14–19, 18 illus.

Engines

The Bristol "Hercules" Aero-Engine. Details on the design and structure of this high-power aircraft engine are given along with some specifications and photographs of components of the assembly as well as the dynamometer test stand used for testing the finished engine. *The Engineer*, December 5, 1941, pages 398–400, 10 illus.

The Bristol Hercules. First in a series of articles on the manufacture of the Bristol Hercules radial sleeve-valve engine. Sleeve-valve design and operation in general, as well as production processes of the cylinder and sleeve, are dealt with in this discussion of manufacturing standards, the cylinder, preliminary operations, concentric and eccentric fins, port milling, machining the sleeve, drilling jig, belt profile, sleeve ports, radiusing the port profile, and pneumatic gauging. *Aircraft Production*, February 1942, pages 176–186, 34 illus.

Avgasenergiens Utnyttjande Pa Flygmotorer (Utilization of Exhaust Gas Energy in Aircraft Engines). Tore Edlen. A continued article on superchargers driven by exhaust gas turbines, this installment presents a survey of conditions and possibilities of application as well as the more important problems confronted.

Details are given on turbine cooling, exhaust gas temperatures, materials for turbine blades, blade temperatures, various cooling methods, cooling of the rotor in order to increase the heat discharge from the blades, and direct cooling of the blades. Control problems and control possibilities are also treated. *Flyg och Motor* (*Technical Supplement*) *Flygning*, October 1941, pages IV–VIII, 6 illus.

Aircraft Engine Directory. Photographs and detailed drawings of representative aircraft engines and installations manufactured in this country are presented in *Aviation's* annual directory issue. *Aviation*, February 1942, pages 184, 187, 188, 191, 192, 22 illus.

Directory of Engine Manufacturers. An alphabetical listing of the personnel and distributors and authorized service stations of aircraft engine manufacturers in the United States, this annual directory is classified by manufacturer. *Aviation*, February 1942, pages 202, 218, 221.

American Aircraft Engine Specifications. Tabular data, in so far as available, is given on the model, dimensions, weights, output, structural material and accessories of aircraft engines produced in the United States. *Aviation*, February 1942, pages 213–215.

Foreign Aircraft Engine Specifications. Tabular data, in so far as available, are given on the model, dimensions, weights, output, structural material and accessories of British, German and Italian aircraft engines. *Aviation*, February 1942, page 216.

Flight Testing

Testing the P-38. Edward Churchill. A description of the tests used in checking the performance of the Lockheed P-38 interceptor. Also noted is the nature of data simultaneously secured with regard to the effect of high altitude flying on the human system. *Flying and Popular Aviation*, March 1942, pages 53, 54, 108, 111, 4 illus.

Testing the Hot Ships. Hickman Powell. A study of the selection and education of Army test pilots whose job it is to run the acceptance and experimental tests at Wright Field is given in this article. What these men's jobs constitute and how they react to their exacted tasks are outlined. The article also explains the general procedure in acceptance and accelerated service tests and explains the rigorous self-discipline which test pilots must exercise in order to perform their tasks efficiently. *Popular Science*, February 1942, pages 52–57, 220, 19 illus.

Gliding and Soaring

The Grunau Baby II. Description of the popular German utility glider, the Grunau Baby II, a braced high-wing type, designed for towed and some types of soaring flight. This glider features a simple all-wood structure of a type proved to be cheap, light and easy to repair. The model differs from the original Baby I in the incorporation of generally cleaner fuselage lines, a single support strut and slightly flattened wing profiles toward the wing tips. *Soaring*, February 1942, 1 illus.

High Altitude Flying

War Goes Into the Stratosphere. Courtney Randall. A summary of the current progress of stratosphere flying, both in experiment and practice. The contribution of Dr. Sanford Moss to the advance of this type of flying is described. General information is given on medical findings with regard to the effect of high altitude flying on aircrew. *Flying and Popular Aviation*, March 1942, pages 36–38, 114, 121, 6 illus.

Hydraulics

The Live-Line Hydraulic Circuit. Edward C. Breinig. An explanation of one of the newest developments in the use of standard principles of hydraulics, this article describes the application of the live-line circuit to modern aircraft design. The fundamental difference of the live-line circuit as compared to a conventional hydraulic system is the elimination of certain units such as the accumulator, regulator and relief valve, and the consequent reduction of plumbing at the negligible expense of a slight increase in pump size and weight. *Aero Digest*, February 1942, pages 159, 160, 222, 7 illus.

Icing

Icing Problems in Aircraft Induction Systems. Leo B. Kimball. Heat and alcohol are the most common deicing mediums, but they offer the disadvantages of loss in power and increased weight. The protected air intake is effective if the rate of water ingestion can be reduced during precipitation and the air temperature raised high enough to be effective during severe icing conditions.

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The ideal induction system is one which requires none of these, and work is being done toward this goal. The research program was initiated by the Special Subcommittee on Induction System De-Icing of the N.A.C.A. The apparatus is described, and the method is outlined for establishing the icing conditions. Types of induction ice are described and pictures of formations found during tests are shown. Preliminary results are summarized as follows:

The rate of ice accretion was roughly proportional to the rate of water ingestion; through the lower temperature range, the smaller the droplet size, the faster was the rate of ice accretion for a given rate of ingestion; the most dangerous condition was found to be around 30°F. air temperature and small droplet size.

Design criteria are set up as a result of this preliminary work which are the basis of rates for making a system which would be substantially ice-free. Some new developments are described, such as two types of flush bulb thermometer and two icing indicators, which would give the delayed action favored by the industry. *S.A.E. Journal*, February 1942, pages 40–51, 34 illus.

Winter Safeguards. Alexander N. Troshkin. The Civil Aeronautics Board power plant specialist summarizes the precautions necessary to safe operation of airplane and engine during cold weather. Discussing engine wear, oil temperature and preheating, starting and ignition, carburetor heat and heaters, cabin heat, water in gasoline, and wind shields, he concludes that there is no reason to curtail flying during the winter months if the proper precautions are taken. *Yankee Pilot*, February 1942, pages 15–17.

Anti-Icing Systems. Harold C. Webb. A general discussion of systems devised to prevent icing on aircraft, this article suggests installations suitable to military and commercial airplanes. They offer a simple and positive de-icing system which consists of minimum equipment and the proper type of fluid intended to remove ice from propellers, carburetors, windshields, pitot tubes, bomb doors, radio masts and other parts of the aircraft exposed to possible ice formations. Wing de-icing systems are omitted from the discussion. *Aero Digest*, February 1942, pages 193, 194, 197, 198, 8 illus.

Instruments

The Measurement of Air Speed. E. B. Moss. A study of the conventional pitot-type airspeed indicator, this article explains the operation of the instrument, its installation and use, offering suggestions for its servicing. Much space is devoted to pointing out the pitot-type airspeed's inherent shortcomings and the accepted way of surmounting some of them. *Aeronautics*, January 1942, pages 27–29, 4 illus.

Final assembly on the B26 light bombers at the Glenn L. Martin plant in Baltimore.

Three Dimensional Seeing. A description of the device made in the U.S. to enable the pilot to obtain a three dimensional view of the ground, simplifying recognition and facilitating emergency landing on unfamiliar territory. In the design of this device advantage is taken of the motion of the aircraft relative to the object viewed. The instrument is not effective for stationary observation of a stationary object. It is essential for the relative motion to be at some angle across the line of vision. The effect cannot be obtained by the motion of the observer when it is directly toward the object viewed. *Flight*, January 22, 1942, page 70f, 1 illus.

Economic Factors of Lack of Instrument Landing Systems. A. E. Blomquist. Eastern Air Lines' Airport Engineer, author of the recent *Outline of Air Transport Practice*, states the case for instrument landing systems in this study of the economy of such systems. He reports that the airlines have suffered from the standpoint of safety, have lost millions of dollars in expenses and revenues, and have also been seriously retarded in developing a dependable service as a result of the great need for instrument landing systems.

Statistics are presented on the basis of Eastern Air Lines' records indicating the costs of delayed and canceled flights caused by the absence of instrument landing systems. It is urged that pressure be brought to bear through the medium of the Air Transport Association to speed the installation of some type of instrument landing system. *Southern Flight*, January 1942, pages 22, 23, 1 illus.

Jet Propulsion

Thrust of Powder Rocket Charges. Roy Healy. A report by the American Rocket Society's experimental committee on the reaction developed by standard powder rocket charges of the types used in signal work. Tests were conducted on three sizes of charges and the conclusion was drawn that although short periods of effective thrust were obtainable from commercial powders they had little value in serious rocket work. *Astronautics*, December 1941, page 6, 1 illus.

Jet Propulsion in Italy. Further details on Italian experiments with jet propulsion airplanes are given in this brief description of the Caproni-Campini C.C.-2, a new and bigger jet propulsion airplane. It is a two seat tandem, enclosed cockpit, low-wing monoplane. Its operating principle is outlined, with data on a test flight. *The Aeroplane*, December 26, 1941, page 697, 2 illus.

Maintenance

Aircraft Repair. Gordon H. G. Garbett. Some of the difficulties and problems which face inspection and planning departments are defined in this article which indicates that inspection is a job for a specialist but that good repair work can be done by semi-skilled men and women. Suggestions are given as to the most likely failures to occur in aircraft and how to repair, reassemble and patch parts and components. Suitable methods for final testing are outlined. *Flight*, January 15, 1942, pages 50e–50h, 51, 6 illus.

Lubrication of Aircraft. James E. Thompson. A brief, generalized study

of the lubrication of aircraft. The selection of lubricants and fluids is discussed along with methods of lubrication and the nature of the process. It is noted that frequency of application is governed by the location, construction, operating facilities, pressures and conditions of moving parts. *Western Flying*, February 1942, pages 50, 52, 54, 56, 2 illus.

Materials

Wood Challenges the Metals. A discussion of new trends in materials, this article treats of the many new applications of wood plus synthetic resins to the development and improvement of products for war and peace. Noting that *with the grain* its tensile strength, weight for weight, is greater than that of structural steel, the properties of the material when impregnated are described briefly. Its uses for the improvement of certain types of airplane construction as a substitute for metals on the priority list and for economy and ease of fabrication are pointed out.

The type of wood required in plywood construction for aircraft and the manner of its fabrication and design as adapted to recent types such as the new Langley two motor monoplane, the Morrow trainer, the Timm trainer and the Fairchild trainer are explained. Included is a rough comparison of the advantages of wood over metal. *Modern Industry*, January 15, 1942, pages 20–23, 12 illus.

Taper Gauge and Butted Tubes. A number of advantages are claimed for the employment of taper gauge tubes in aircraft construction. Conditions governing the manufacture of these tubes, as well as their possible application, are reviewed. *Aircraft Production*, January 1942, pages 147, 148, 1 illus.

Ceramic Filters. A brief account of filter tubes for aircraft rate-of-climb indicators which contends that the current British-made product is in every way comparable with that previously imported from Germany. *Aircraft Production*, January 1942, page 148, 1 illus.

The Dubilier Rivet. The claim is advanced for this new type of self-heading rivet that a connection made by it cannot be broken except by destruction of the rivet itself or rupture of the work. Study of the head formation, relative strength, variations, and types of shanks reveals why it requires no special preparation of the holes, no application of heat, no tool other than a hammer and how it can be set only from one side of the work. *Aircraft Production*, February 1942, page 217, 2 illustrations.

A Device to Simplify Testing Near Point of Convergence (PcB) in the Angle of Convergence Test. Capt. Robert Cohen. Some details in support of the contention that this device keeps the pin at a uniform height above the edge of the Prince rule, maintains uniformity of motional speed toward the nose, assures exact point of stoppage, and enables the examiner to concentrate on the examinee. *The Journal of Aviation Medicine*, December 1941, pages 298–299, 2 illus.

Remarks on Developments in Aviation Medicine for the Year. Capt. J. C. Adams. Reviewing the year 1941, experiments and progress are recorded in the fields of gravitational stress, night blindness, aniseikonia, and pilot selection and training. Noted, too, is development in operational problems and specialization in flying. *The Journal of Aviation Medicine*, December 1941, pages 280–283.

Problems in Aviation Medicine Affecting Military Aviation. Col. David N. W. Grant. A consideration of the human coefficient in the efficient operation of military aircraft. Major physiological and psychological problems and what the Air Force is doing to solve them. *The Journal of Aviation Medicine*, December 1941, pages 274–279.

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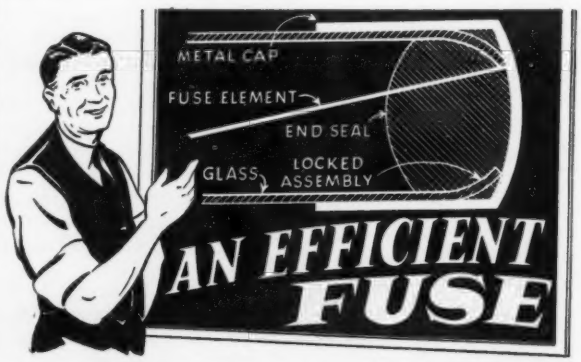

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Medicine

The Removal of Carbon Dioxide From Rebreathing Appliances. John Adriani, M.D. The chemical absorption of carbon dioxide by soda lime from rebreathing units, particularly those used in anesthesia, is described. The comparative data are considered from physiological, chemical and physical viewpoints. *The Journal of Aviation Medicine*, December 1941, pages 304–309, 2 illus.

Metallurgy

Surface Hardening of Stainless Steels. Edmund A. Malcolm. An examination of new processes in the surface hardening of stainless steels such as the 12 to 14 per cent chromium stainless steel, 18-8 chromium and nickel and the 20-19 nickel chromium stainless steel. Surface hardening is taken by the writer to be the ideal solution to engineering problems requiring materials to withstand stresses at high temperature, resist abrasion at high speeds and high unit pressures and maintain certain corrosion resistant property.

The subject is here treated less from the standpoint of the metallurgic details of the process than from the viewpoint of new properties which can be developed in a metal by this process so that the metal becomes more useful or more economical than previous metals or processes used. The process described was developed in the research laboratory of the Chapman Valve Manufacturing Co.

It is carried out in two steps. The first prepares the metal for its acceptance of nitrogen and the second for the actual introduction of nitrogen from dissociated or ionized ammonia into the material to be treated. Details of the method are given along with the properties to be obtained. *Aero Digest*, February 1942, pages 172, 174, 177, 272, 273, 10 illus.

Meteorology

Making a Forecast From the Weather Map: the Empirical vs. Physical Methods Popularly Compared. Maj. Wm. H. Wenstrom. Since 1930, the full application of air-mass-and-front analysis has completely revolutionized temperate-zone weather analysis and forecasting. The differences between these old and new methods of weather forecasting, and certain rudimentary data on the whole complex technique of modern physical weather analysis are described in this paper. It is said that the physical method is less cursory and more laborious, but is also more thorough, more logical and leads itself to forecasts that are more specific and more accurate. *Bulletin of the American Meteorological Society*, December 1941, pages 403–405.

Military Aviation

Flying Squadrons. S. Paul Johnston. "All arguments of syndicated experts and other columnists to the contrary," says this writer, "air power alone cannot win wars," but, he contends, the airplane *is* changing the course of history, just as did gun powder and the iron clad. The speed, range and load-carrying abilities make the airplane probably the most effective instrument for warfare ever devised, but it must be looked upon only as another weapon, an adjunct to armies and navies and not as a be-all or an end-all.

On this keynote the writer proceeds to describe the mission and makeup of the U.S. Army Air Forces. The evolution of policy in the development of the Air Forces is traced with an explanation of the reasoning behind it. The function and performance of various types of aircraft and of the several branches of the service are described. *The Technology Review*, December 1941, pages 77, 78, 92, 94, 96, 97, 1 illus.

Sky Destroyers. Carl Dreher. A brief analysis of the support given by military air maneuvers in conjunction with ground operations. In addition to a comparison of present air support strategy with an earlier state of tactical procedure, the article touches on training, experience and enterprise of personnel; offensive weapons, including airplanes and their armament; communications and control and strategic location of airports. *Popular Science*, February 1942, pages 82–89, 11 illus.

Stuka! W. B. Courtney. An account of the development of dive bombing and its effectiveness in air war operations. Dive bomber pilots are the "supermen of the air," fed and conditioned like prize athletes. Their desperate work is done close to the ground and the Germans by research and patient experimentation "are now able to bring it even closer." The writer's observations are based on first hand contact with this element of the *Luftwaffe*. *Collier's*, February 14, 1942, pages 14, 15, 49, 50, 52, 1 illus.

Grasshoppers. Hickman Powell. One of the latest additions to the U.S. Army's varied stock of aircraft is the "Grasshopper" or auxiliary messenger-observation type of aircraft. Utilizing standard light trainers such as the Piper Cub, the Taylorcraft and the Aeronca for command-control message carrying, observation, traffic direction, taxi and general utility work, these craft formerly held in contempt by some military experts have proved themselves indispensable to cavalry and field artillery groups. The article relates the incidents leading up to their first use during maneuvers last year and points out the increased opportunities for their application in modern warfare. *Popular Science*, January 1942, pages 63–67, 16 illus.

Bombing. A table is presented in an attempt to clarify the nature of different forms of bombing attack. The classification is inevitably arbitrary and the layers chosen to distinguish the different bombing levels are in themselves open to controversy.

The composition of the table assumes that, normally, bombing is not performed at heights between 500 ft. and 7,000 ft. The layer bounded by these two heights is that in which anti-aircraft fire is likely to be prohibitively accurate over heavily defended areas. Where the anti-aircraft defenses are less powerful and cloud cover is available, ground bombing from any height to suit the prevailing weather is common practice and gives the best results.

The relative merits of the different kinds of bombing depend upon the nature of the target. In the table the more obvious targets are listed with the kind of bombing that is most effective against them.

Strictly speaking, the torpedo and the heavy cannon should not appear in the table, but they have been included for completeness. Against certain types of target the torpedo and the cannon are far more effective than the bomb. Recently, in the Pacific, the torpedo has scored notable successes, which give some indication of the future possibilities of this weapon. A cannon-armed "tank buster" is urgently required. *The Aeroplane*, January 9, 1942, page 43, 1 illus.

Military Aircraft Types—Army and Navy. A list of the various makes and types of aircraft in American military and naval service. The data include the manufacturer, the type designation and the service in which used. Airplanes are grouped under the class of operation which they perform in the various air services. *Aviation*, February 1942, page 91.

Ferry Command. The job of delivering to Britain the bombers built in the United States is shown to have passed the experimental stage. It was first handled by the Canadian Atlantic Ferry Organization but has now been transferred to the Royal Air Force Ferry Command. Pictures cover some of the activities at the

special selection center and training school, the new airfields and other facilities which are organized like a smoothly-operating railway system. *Air News*, January 1942, pages 28–29, 11 illus.

Naval Aviation

America's New Carriers. Photographs and brief descriptive data on the latest additions to the U.S. Navy's air strength. Problems in the folding of the wings of torpedo bombers based aboard aircraft carriers are noted with a description of the method for wing folding used in the handling of the Douglas Devastator torpedo bomber and the Vindicator dive bomber. *Flight*, January 22, 1942, pages 68–70, 8 illus.

Flying As It Was. John Burket. Recounting the exploit of Eugene Ely in making the first successful landing of an airplane on a Naval vessel, this article gives further information about the historic event which took place January 18, 1911, in San Francisco Bay. The method of bringing the airplane to a stop on the temporary landing platform erected on the afterdeck of the U.S.S. *Pennsylvania* is described. It is fundamentally the same as that employed today. The account covers the plans made for this epochal event and concludes with a description of Ely's take-off for the return to Selfridge Field and his reception later. *The Sportsman Pilot*, February 15, 1942, pages 18–19, 32–33, 4 illus.

Personalities

Majoor Versteegh Dertig Jaar Vlieger (Major Versteegh, Thirty Years a Flyer). On November 2, 1911, the erstwhile military aviator who is now director of the K.N.I.L.M. airline, Major W. C. J. Versteegh, received his international pilot license. He organized the Dutch military aviation service and brought it to a high grade of efficiency. He was about to retire from military service when the position as chief of the K.N.I.L.M. was offered to him. As a great organizer he devoted himself to making the K.N.I.L.M. what it is today. *Vliegwereld*, November 5, 1941, page 633, 2 illus.

Cronicas y Divulgacion Popular—Wiley Post (Popular Biographies—Wiley Post). A lengthy chronicle of the career of this famous flyer, depicting the highlights and many of the sidelights of his active aeronautical record. *Aeronautica Argentina*, October 1941, pages 2071, 2072, 2075–2078.

Army's No. 1 Test Pilot. That a test pilot is far more than a superstuntsman and bears a closer resemblance to a laboratory technician is pointed out in this brief review of the activities of Lt.-Col. Stanley M. Umstead, the Army's chief test pilot. To the coolness and quick judgment of a born flier, he is said to add the precision and thoroughness of a scientist. Photographs show a few of the many activities and responsibilities of the men who test the airplanes purchased by the Air Force, as well as commercial and experimental types offered for procurement, from light trainers to the world's largest bomber. *Air News*, January 1942, pages 34–35, 12 illus.

Plants

La Fabrica Militar de Aceros (The Military Steel Plant). For quite some time arrangements have been made to work out a plan which would make it possible to satisfy to a certain degree the requirements of the ordnance department of the army. The establishment of a military steel mill was absolutely necessary and the results so far have been satisfactory. There are two furnaces and a well equipped rolling mill which puts out steel plates of 580, 425, and 300 mm. gauge. *Aeronautica Argentina*, October 1941, page 2043.

Organizing Little Plants for Big Production. Jack Frost. The executive secretary of Aircraft Parts Manufacturing Association describes this organization's cooperative program to organize small plants for big production in the aircraft tool and part field. *Aviation*, February 1942, pages 108, 308, 311, 312, 5 illus.

Personnel

Women in Industry. This report is confined to the operations now being assumed by women in the manufacture, repair and assembly of airframes and components only. Utilization of female labor has now been extended in these fields to include inspection training courses, riveting, welding, wiring, details fitting and small sub-assembly, as well as progress planning and draftsmanship.

From a survey of present methods in British factories, it concludes that as women are performing practically all operations, with the exception of main assembly of heavy bombers, the majority of firms should be able to dilute with women up to 65 or 75 per cent of their total strength if subsidiary obstacles are overcome. *Aircraft Production*, January 1942, pages 152–156, 12 illustrations.

Women Wanted. Donald O. Herty. Wartime demands on American manpower have opened many jobs in the airline business for which women can qualify. This article points out the nature of some of them, the qualifications required, and how to go about obtaining them. *Flying and Popular Aviation*, March 1942, pages 29, 98, 100, 102, 1 illus.

Check Pilot. Capt. Edgar J. Wynn. The job of testing pilots for advanced military flying is described by a former R.C.A.F. check pilot. He presents the various qualifications that must be checked on in testing the flying abilities of pilots in flight. *Flying and Popular Aviation*, March 1942, pages 55, 84–86, 90, 1 illus.

Selective Service and the Aircraft Worker. Brig. Gen. Lewis B. Hershey. The director of Selective Service discusses the effect of drafting manpower upon aircraft and related industries. He indicates that it is the intent of Selective Service officials to build up our armed forces with the least possible impairment of essential industrial production. The present application of this policy is interpreted. *Aviation*, February 1942, page 106, 1 illus.

Photography

America Poses for Its Picture. Kurt Rand. A description of the work being done by the Cartographic Division of the Soil Conservation Service, U.S. Department of Agriculture, in a program to produce mosaic aerial maps of the country as an aid to soil conservation and to the protection of defense plants. *Flying and Popular Aviation*, March 1942, pages 39, 40, 104, 108, 4 illus.

Plastics

Rolling Off a Log. Thomas D. Perry. A review of the many new uses in defense that have been found for plywood as a construction material as a result of the development of synthetic resin adhesives. Various types of common plywood construction are described—types in which wood compression is nominal and only enough to bring the veneer surfaces into close contact. Various types of high-density plywood are also accounted for.

They differ in the ratio of wood fiber to resin, in the pressure exerted and in the kind of resin used. Variable-density construction, in which more layers of veneer are used at one end than at the other and the whole assembly is compressed to an even thickness, results in greater compression and higher density at one end.

The physical characteristics of plywood are noted with emphasis on the ability to predetermine density and

strength as a facility that exists with few basic materials. Comparable with the alloying and heat-treatment of metals, this procedure has an even wider range of practical applications, some of which the writer describes, for example, as skin covering for the wings, tail parts, rudder, ailerons and stabilizers of airplanes; fuselages of molded monocoque shapes; molded noses and nacelles; spruce spars; plywood ribs and propellers. *The Technology Review*, December 1941, pages 72–74, 88, 90, 92, 6 illus.

Factors Influencing Creep and Cold Flow of Plastics. J. Delmonte and W. Dewar. Describing tests conducted upon specimens of various plastic materials, the writers set forth the methods used for developing fiber stress, measuring deflection and recovery, plotting the data and noting the results of the experiments. Inaccuracies in measurements are noted, as well as the effects of time and temperature.

It is concluded that the often-neglected creep and cold-flow phenomena become increasingly important for thermoplastic materials at temperatures above 80°F. The resin bonded veneers are found to behave very well as compared with plastics. It is further concluded that thermoplastics in structural applications above 85°F. should be viewed with a great deal of caution, because, while physical constants such as the modulus of elasticity and tensile strength do not change greatly, the creep values do. *A.S.T.M. Bulletin*, October 1941, pages 35–41, 13 charts.

Growing Use of Plastics. A brief note on the variety of uses to which plastics are being put in the construction of aircraft parts. *Aircraft Production*, January 1942, page 126, 1 illus.

Deformation of Plastics Under Load. A method of test is described covering the procedure for determining the deformation of plastics under compression of nonmetallic sheet and molded materials of all classes and all commercial thicknesses, intended for structural and insulating purposes. The apparatus, test specimens and the procedures to be followed are set forth. *Modern Plastics*, February 1942, pages 72, 112, 114, 116.

An Engineer Looks at Plastics. J. R. Townsend. An engineering consideration of factors important in the use of plastics where continued, safe service is desired. The discussion presents reliable data for use in design, and treats of those aspects relating to performance under service conditions. The application of plastics as an electrical insulating material and as a construction material is outlined. Seven major points which an engineer must take into account in applying plastic materials are set forth. Tabulations are furnished covering the properties of various types of plastics and comparing them with other materials. *Modern Plastics*, February 1942, pages 56, 57, 108, 110, 112.

Structural Plastics in Aviation. J. B. Johnson. The chief of the Materials Laboratory at Wright Field presents a brief survey of the current progress in the use of plastics as a material for airplane construction. He restricts the term "plastics" to those products in which the synthetic organic resins are used in sufficient quantities to influence the specific gravity and mechanical characteristics. Details are given on methods of testing for the mechanical and physical properties of plastics applicable to aircraft construction. *Aviation*, February 1942, pages 103, 104, 314, 317, 5 illus.

Production

Stretch Pressing. This report of the use of stretch pressing in its particular application to aircraft describes the principles and mechanics of the process, the materials and tools to which it is adaptable, and the resultant economies effected. *Aircraft Production*, January 1942, pages 121–125, 12 illus.

Can the Japs Produce? James L. H. Peck. Tracing briefly the history of Japanese military aviation, this article touches on the operations and products of the seventeen major aircraft and engine plants in the island empire and evaluates the resources of the nation in the raw materials necessary to build and maintain an adequate air force. It is indicated that Japan may have a maximum of 5,000 military and naval airplanes, of which 1,500 are trainers and the remaining 3,500 combat craft are about equally divided between the army and navy air arms. It seems unlikely to the writer that Japan can maintain an output of 500 units monthly. The conclusion is reached that the Japanese will be unable to match the output of their opponents in either quantity or quality. *Air Trails*, March 1942, pages 12–13, 52, 4 illus.

Automatic Riveting in Aeroplane Construction. A brief summary of the technique used for automatic riveting in the fabrication of airplanes, this article describes two machines developed in Germany. *Aircraft Engineering*, January 1942, pages 23, 24, 8 illus.

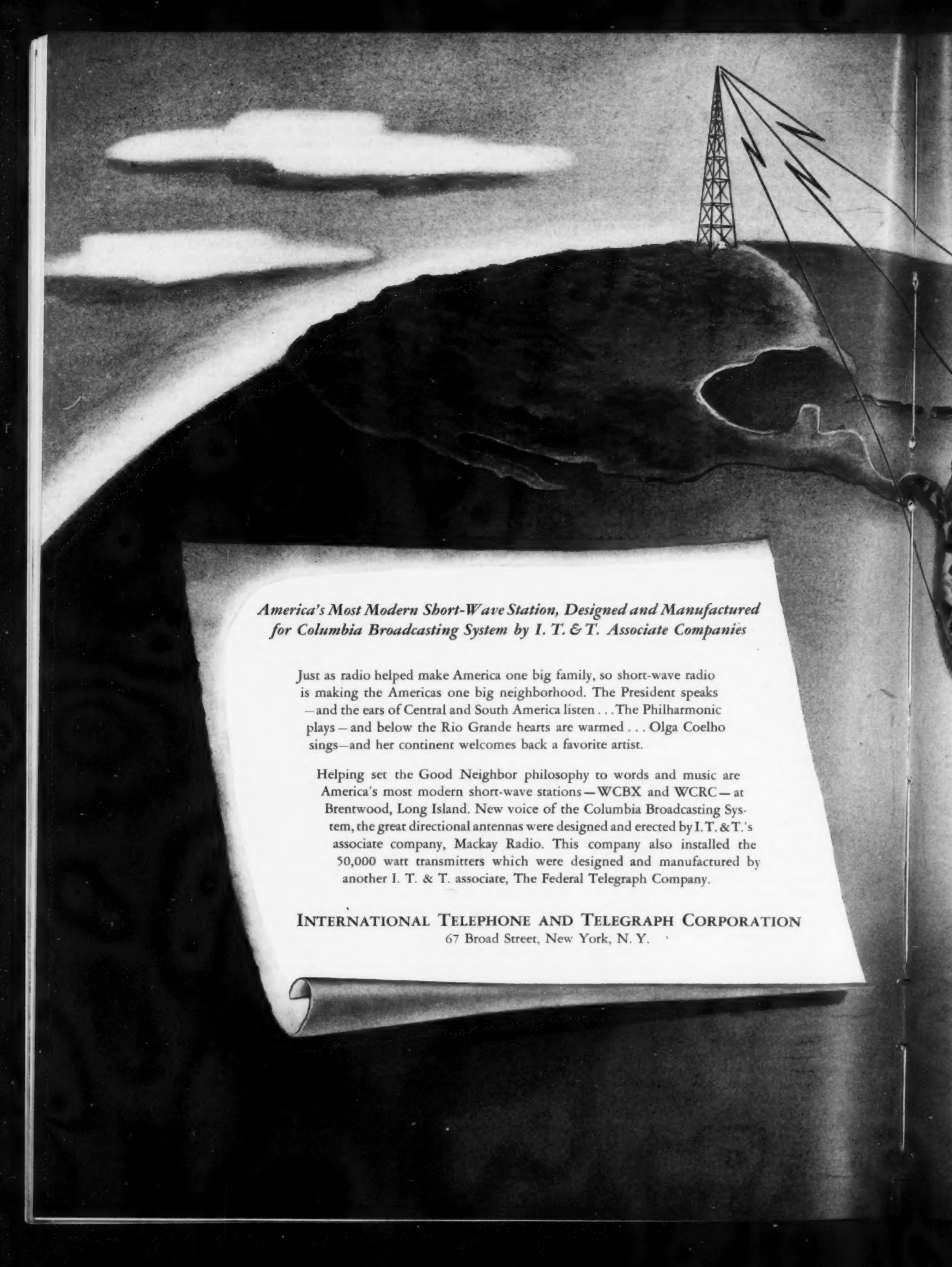
Time and Motion Study. Gordon H. Garbett. A discussion of the method of industrial psychology being applied in British aircraft factories to step up the output of aircraft, power plants and accessories. The article examines the science of time and motion study, indicates methods for its application to aircraft production and lays out formulas and methods of plant and work rearrangement for maximum production efficiency. *Aeronautics*, January 1942, pages 55–57.

Mass Production for the Aircraft-Engine Industry. H. E. Linsley. An examination of mass production methods which have been developed to speed up wartime production of aircraft engines. The analysis is based on the experience of Wright Aeronautical Corporation and details the evolution in this company's plants of new and improved methods for stepping up production to a mass basis. Also described are the special machinery and equipment which have been devised to increase the number of units which can be produced on a single machine, as well as to cut down on time required for unit operations. *Mechanical Engineering*, February 1942, pages 100–105, 6 illus.

The Control of Scrap in Machine Shops. C. R. Nortcliffe. Helpful suggestions for the reduction of spoilage caused by machining operations. Particular emphasis is placed on attention to six preventatives: discrimination in appointing staff, compiling weekly spoilage statistics, "batching" of raw materials, adopting the most efficacious inspection system, design and maintenance of tools and fixtures, daily checking of machine shop and inspection gauges. The author's conclusion is that a coordination of planned inspection with planned production will result in improved output on a more economical basis. *Aircraft Production*, January 1942, pages 149–151.

Shop Transport. The savings that may be effected by efficient exchange of work between machines and departments are covered by this discussion. The merits of trolleys and wheeled assembly stands for this purpose are evaluated by examples of various types used in different aircraft plants. *Aircraft Production*, February 1942, pages 172–175, 9 illustrations.

The Blackburn Botha. Part III. Wilfred E. Goff. The third and concluding installment on the design and fabrication of the Botha is concerned with the construction of the fuselage.



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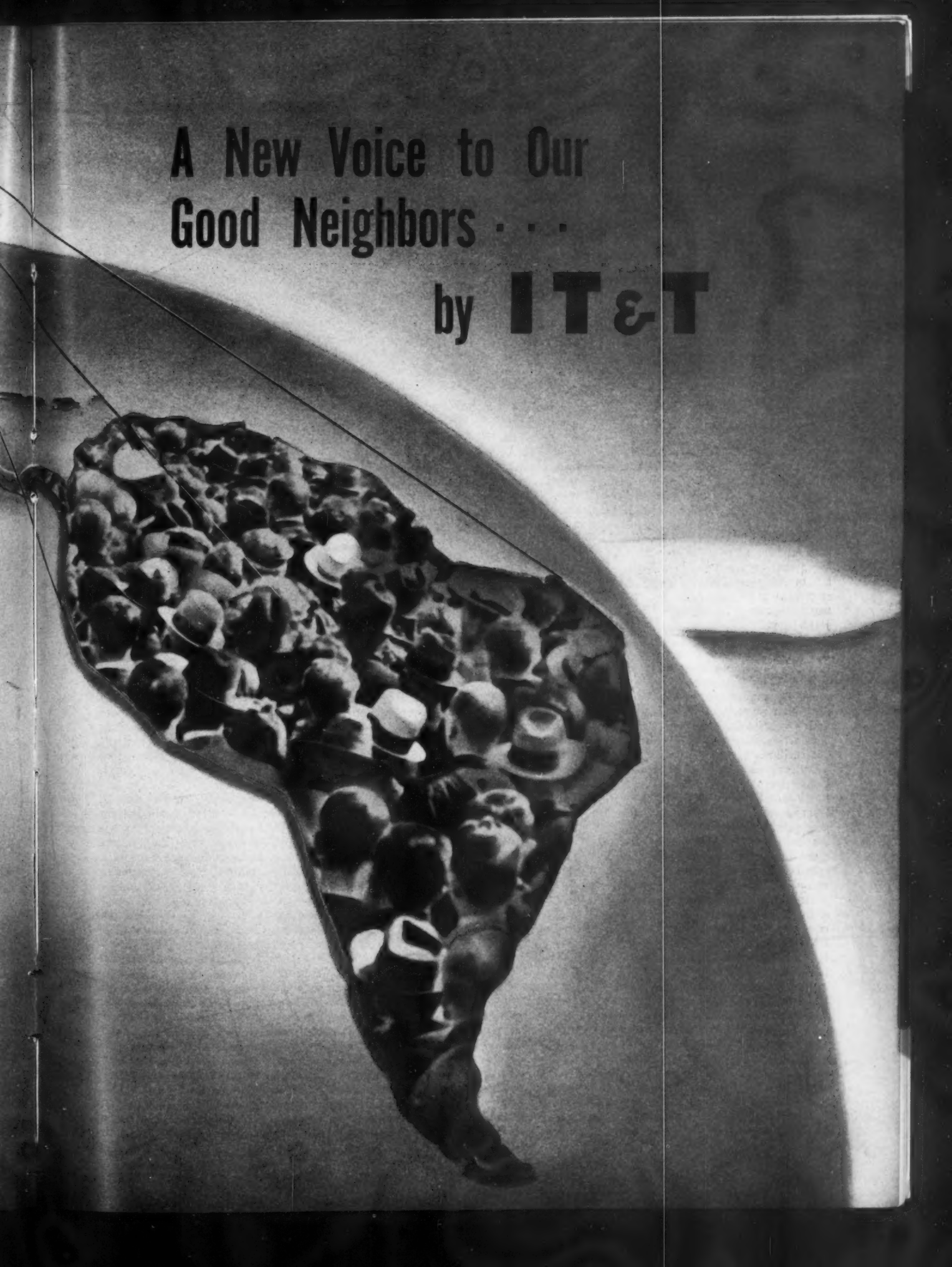
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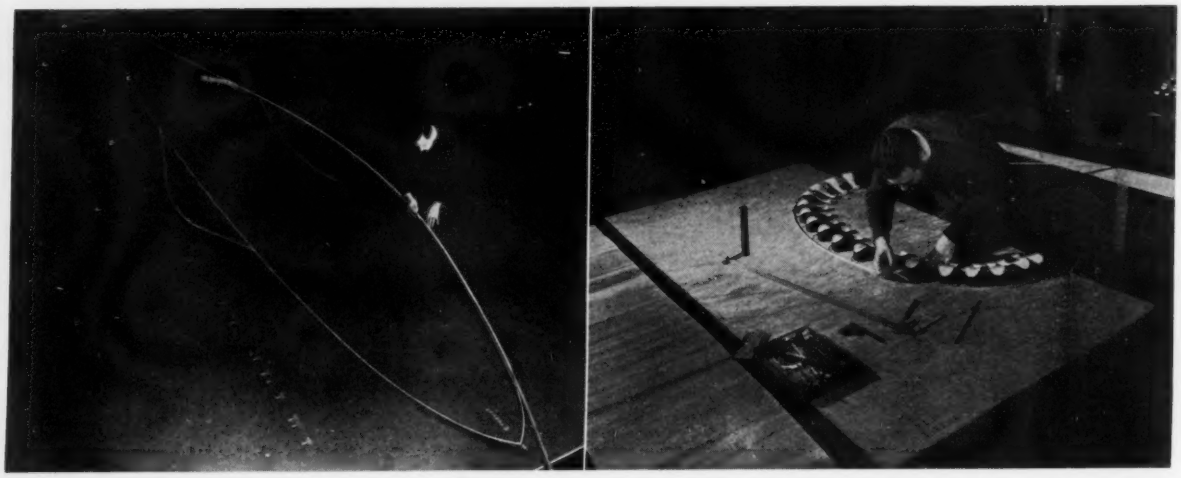


Lofting at the Bell Aircraft plant. (Left) Drawing the full-size outline of the airplane on the lofting floor. (Right) Drawing a composite view of a bulkhead, full-size on plywood.

It describes in detail the five sections, which are built in separate jigs, and concludes with a review of the final assembly processes. *Aircraft Production*, January 1942, pages 129–138, 24 illus.

Assembly of American Aircraft. A brief answer to some of the adverse comments on the delay in the assembly of American aircraft in England reiterates that modifications are always necessary because of the constant development of design. The assembly of the Douglas Boston, the North-American Mustang, and the Curtiss Kittyhawk are depicted as examples that various adjustments must be made before airplanes of American manufacture are ready for active service in England. *Aircraft Production*, January 1942, pages 127, 128, 3 illus.

Allison Set For Peak Production. Changes in the production methods at the Allison Division of General Motors from small-lot output to flow-line production are described, with information on the special single-purpose machines, jigs and fixtures which speed the output of engine components. Methods used in inspecting parts as they come from other divisions and outside suppliers are covered, with reference to the problems that have been overcome, including the special practices developed for working with light alloys.

Detailed descriptions follow, setting forth in text and in tables the operations on the cylinder head and block. Photographs show numerous operations on special machines, and a sketch of the layout of the anodizing and paint rooms is reproduced. *American Machinist*, March 5, 1942, pages 165–177, 14 illus.

We'll Do the Job. Col. John H. Jouett. An analysis of the expansion needed in America's airplane production to meet the 60,000-unit objective called for recently by President Roosevelt. The writer asserts that the goal can be accomplished and explains his reasons for this belief. *Flying and Popular Aviation*, March 1942, pages 24–26, 73, 5 illus.

Calculations for Joggle Dies. Edward J. Rantsch. To eliminate much of the guesswork in the design of joggle dies, both for sheet metal and extrusions, a formula is presented for calculation that gives most satisfactory results. The formula is explained along with spring back allowance on extrusions and the die dimensions necessary as calculated by the formula to produce a certain joggle on the work. *Aero Digest*, February 1942, pages 136, 271, 2 illus.

Lofting Problems of Streamline Bodies. Carter M. Hartley and Roy A. Liming. The third installment of this article expands the field of application of the second degree method in basic design and lofting to include certain subsidiary developments, such as wind shields, turret blisters, observation compartments, wing fillets, etc. In the past, such components have commonly been developed by the standard proportional curve technique. *Aero Digest*, February 1942, pages 151, 154, 210, 5 illus.

Production 24 Hours a Day. Milton F. Baldwin. An open letter to factory personnel directors on the subject of the training of ground crew to provide efficient maintenance of airplanes in the armed services and of supplying a sufficiency of manpower in factories to permit 168 hours per week of effective airplane production. It is pointed out that the supply of manpower must come from four groups: men below or above draft age; men with physical handicaps not prohibiting factory work; men whose status on dependents allows deferment; and women.

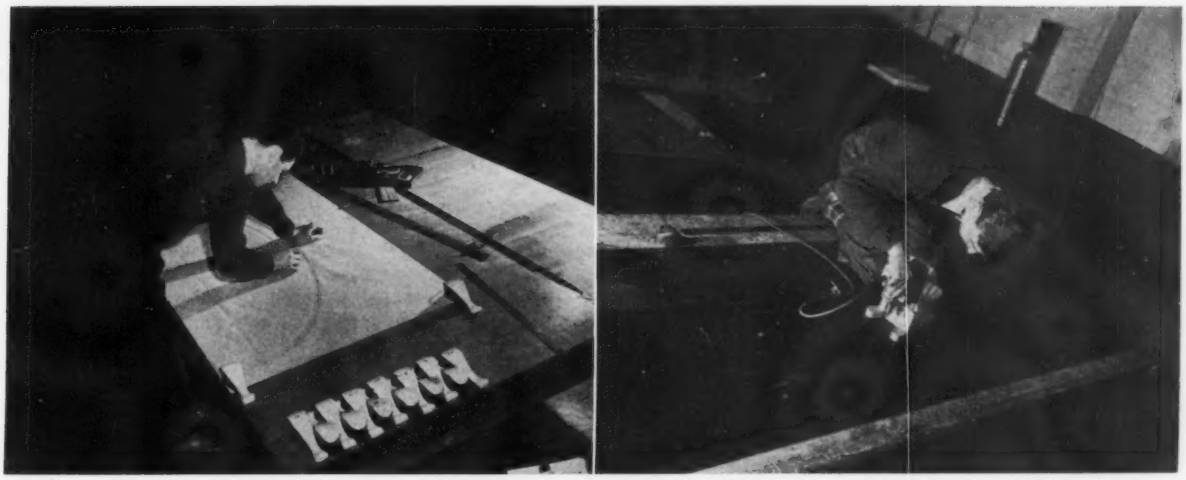
The use of reputable and competent private schools is suggested as a source of training for these classes of personnel on the basis that Government contract of such schools could be operated just as effectively, as has been proved by Government contract of private schools for the training of pilots. *Southern Flight*, January 1942, pages 28–30.

1941 Civil Plane Production Sets New Record. A summary analysis of civil airplane production in the United States during the year 1941 is given in this report of gains registered by light airplane manufacturers. Note is made of the advance of this class of craft to military service as a result of air maneuvers toward the end of the year. *Aviation*, February 1942, pages 84, 85, 4 illus.

Jacobs Jumps Into Big League. J. A. Harris. A survey of the present status of engine production in the plant of Jacobs Aircraft Engine Co. After considerable expanse since June 1940, the company is now preparing to more than double present engine production through construction of a new plant to produce Pratt & Whitney engines under license. *Aviation*, February 1942, pages 94–96, 8 illus.

Photo Templates Speed Production. G. T. Allen. A series of photographs showing new improvements in the application of photography to the making of templates for aircraft fabrication. Captions explain the nature of the system now being used at Lockheed Aircraft Company. *Aviation*, February 1942, pages 98, 99, 18 illus.

Directory of Aircraft Manufacturers. An alphabetical listing of the personnel and distributors of air-



(Left) A Bell loftsman making a tracing directly from a body plan. (Right) Cutting out the final steel template and locating rivet holes.

craft manufacturers in the United States, this annual directory is classified by manufacturer. *Aviation*, February 1942, pages 195, 196, 199, 201, 202.

The Mechanics of Deep Drawing Sheet Metal Parts. Given Brewer and Mrs. Mabel MacFerran Rockwell. The processes of forming sheet metal have been widely affected by the wartime trend toward mass production of aircraft. The double-acting press has therefore been evolved for this type of production. This article describes the mechanics of deep-drawing sheet metal parts, and gives details on the use of this type of press, along with an explanation of the principles of its operation and its application to the manufacturer of aircraft parts. *Aero Digest*, February 1942, pages 126, 128, 131, 132, 135, 15 illus.

Propellers

The D. H. Four-Bladed Airscrew. Drawings with a brief description are presented to show the principal features of the new four-plated propeller developed by deHavilland. *Aircraft Engineering*, January 1942, pages 14, 15, 3 illus.

Rotol Jablo Wood Airscrew Blades. W. Brierley. The advantages of wood propeller blades over metal blades are indicated in this description of the materials, supplies, tools and methods used in the manufacture of the rotol Jablo wood propeller. *The Aeroplane*, December 26, 1941, pages 704, 705, 8 illus.; January 2, 1942, pages 14, 15, 21, 13 illus.

Radio

Vliegtuigen Zonder Vliegar (Unmanned Airplanes). Allen Finn. As a result of the discouraging results of anti-aircraft fire during the first World War, various countries have taken steps to devise means to make anti-aircraft fire more efficient. Whereas in Germany and the United States, model airplanes are used for target practice, the English have radio-controlled airplanes of the Queen Bee and Queen Wasp type.

These airplanes are catapulted and have a 350 hp. engine which delivers a maximum speed of 340 km. per hour. They are also equipped with a landing gear. Through a radio system, they are controlled from the ground by a flyer who puts the airplane into such motions that it becomes a very evasive target.

The first such airplane flew in 1930. It was built by the Royal Aircraft Establishment. However, the English Government did not make these tests public until 1935, when demonstrations were made with the Queen Bee. This was a Tiger Moth with a 130 hp. engine. It was very maneuverable and could stay in the air for about an hour. Encouraging results of these experiments led to the construction of the Airspeed Wasp. This craft has a 350 hp. Cheetah engine and radio-controlled landing flaps.

The English Navy is much interested in this type of airplane and the aircraft carrier Argus has special equipment for it. Besides their use as targets, the probabilities of radio-controlled airplanes for attacks on troop concentrations, fortresses, seaports and airports are obvious. Furthermore they are said to be excellent for special photographic work.

It is said that experiments are in progress in the United States with this type of airplane, especially with a view to controlling such aircraft from regular piloted airplanes. The latest experiments are being made with television, and scientists predict that television-controlled airplanes will certainly be used in the present war. *Vliegwereld*, November 27, 1941, pages 682, 684, 2 illus.

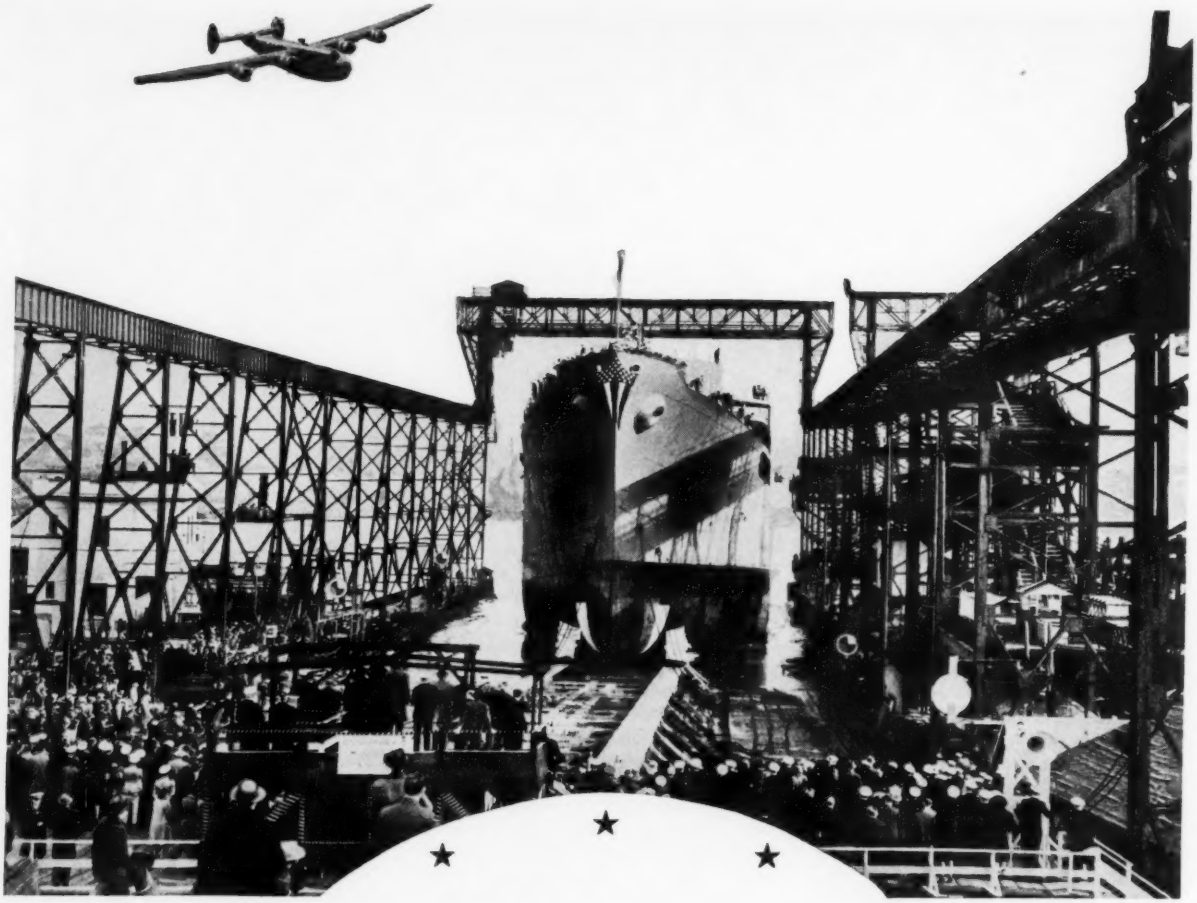
Research

Research in Germany. Summary observations on present-day air research in Germany. Tremendous efforts are being made, it is said, both in Germany and the occupied countries, to increase production to counteract both the losses in Russia and the effect of American entry into the war. This concentrated activity is apparently delaying the bringing into service of new types. Most of the present aircraft production is on improved versions of familiar airplanes. Behind this concentrated production front a great deal of research, it is said, is being conducted through the German aircraft industry and in the DVL.

Data, said to be authenticated, are given on the trend of design, the engine development, propeller development, new types of aircraft and gliders under this intensive research program. *The Aeroplane*, January 23, 1942, page 94, 1 illus.

Aircraft Industrial Research. Maurice Nelles. The senior research engineer of Lockheed Aircraft Corp. defines present-day research as the process of obtaining facts and data. Most research problems are the adaptation of data already used in other applications to problems at hand. In the course of applying these data, new data are obtained and new applications found. Industrial research is held to be a service to the rest of an industrial organization.

The writer describes the best meth-



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ods of organizing a research service for effectiveness and how to operate such an organization most efficiently. Cooperation is regarded as the key to the most effective research. The research organization at Lockheed Aircraft Corp. is outlined with an explanation of the work of the several research groups which include the mechanical, production, structural, electrical and chemical fields. *Aero Digest*, February 1942, pages 201, 202, 205, 206, 221, 222, 16 illus.

Rotating Wing

Helicopter Design. J. Lockwood Taylor. Elementary considerations are presented on the efficiency and control of the helicopter type of aircraft. Torque reaction and performance are discussed with reference to the inherent possibilities of this type aircraft and on the assumption that development difficulties have been overcome.

It is suggested that something about stability is to be learned from the autogiro, and that control, particularly the twin problem of directional control and torque reaction elimination, seems to be the outstanding difficulty, the complete answer probably reposing in some combination of the various methods outlined or involving the use of gyroscopic stabilization. *Aircraft Engineering*, January 1942, page 18.

Stress Analysis

Torsion in Box Beams. J. H. Payne. Detailed notes are given on the effect of end constraint in torsion boxes of rectangular section. The effect of axial constraint on box beams of approximately rectangular section, subject to torsion, is important in the stressing of two-spar skin-covered wings. Previous investigations indicate that the use of simple bending theory involves a negligible sacrifice in accuracy as compared with the use of more rigid methods.

The axial stresses in the box beam subjected to a system of torsion loads are said to be due to axial constraints. The stresses at any section of the beam are regarded as being the sum of the stresses due to each source of axial constraint taken separately. This concept serves the basis for the development of relatively simple equations for the bending moments, and secondary shear stresses, due to axial constraint. *Aircraft Engineering*, January 1942, pages 2–8, 13 illus.

Shear Strength of Molded Plastic Materials. John Delmonte. The punch and die are described in the measurement of shear strength upon molded plastic parts as a useful tool for a rapid method of evaluating this property by molders. Test results upon phenolics and ureas which have been cured for different periods of time are described. It is pointed out that differences in shear values of molded phenolics are augmented by several minutes immersion in acetone, whereas boiling water may be used to reveal substantial variation in the cure of molded urea parts and their shear strength.

Comparative tests upon a large number of injection molded pieces produced in the same mold are outlined, and a table is prepared comparing these materials with respect to shear strength. Injection moldings of polyvinyl chloride-acetate and polymethyl methacrylate proved to be the highest. Further tests designed to show the utility of the punch and die reveal data on the shear strength of molded plastics as function of temperatures from 0 to 300°F. *A.S.T.M. Bulletin*, January 1942, pages 25–28, 4 illus.

Eccentricity in Columns. Kenneth G. Merriam. By relating eccentricity to slope at the end of a column, the mechanism of eccentricity behavior in flat-end loadings is discussed.

For both flat-end and pin-end cases, explanation is offered for the experimentally observed tendency, at failing loads, for the grouping ec/r^2 (called γ) to assume a value below a definite maximum.

Two non-dimensional graphical representations of the load-maximum stress relation for columns are given, and values of length and γ are stated for use with such charts, which can be employed to solve most column problems involving primary failure by translation, regardless of slenderness ratio or material involved. *Journal of the Aeronautical Sciences*, February 1942, pages 135–137, 3 illus.

Torsional Center Determination in Stressed Skin Structures. Dr. Michael Watter. In the light of a practical engineering approach to everyday problems of structural analyses and design, a method is presented for the determination of the torsional center and its use in skin-stressed structural design. The method is grapho-analytical and although some engineers seem to question the accuracy possible with graphical methods, in most instances the accuracy of construction is greater than the available knowledge of the structures analyzed. The value of simplified calculations which provide a reasonable degree of accuracy is reiterated by the writer who urges the wider use of graphical methods because of the rapidity of execution and the ease of verification. *Aero Digest*, February 1942, pages 145, 146, 7 illus.

The Effects of Accelerations on Man and Machine. Carlos F. E. Regniar. A simplified explanation of the phenomenon of acceleration in terms of the structure of an airplane and the bodies of the air crew. The nature of acceleration is described with its effect on airplane and pilot during varying degrees of turns, dives and pull-outs. *The Royal Air Force Quarterly*, September 1941, pages 357–370, 9 illus.

Buckling of a Column With Non-Linear Lateral Supports. H. S. Tsien. During previous investigations by the author and von Kármán and Dunn, of the California Institute of Technology, of the buckling phenomenon of thin cylindrical shells and thin spherical shells it was found that the non-linear load vs. deflection relation gives a buckling phenomenon entirely different from the classical theory. Experiments on a column with non-linear lateral supports show that the essential characteristics of the buckling of curved shells can be reproduced with this structure. The problem of a column with non-linear lateral supports is, however, much simpler than the problem of curved shells, and an exact solution can be obtained without any mathematical difficulty. In the present paper, an exact solution of the column problem is carried out. The statements in the present paper are subject to a quantitative verification, not by attacking the shell problem itself, which is too complicated, but by solving the similar problem of a column supported laterally by non-linear springs. A new interesting fact is found, that a straight unbuckled column may have an elastic energy and end shortening equal to those of a buckled state with finite deflection even at a load far below the classical buckling point. *Journal of the Aeronautical Sciences*, February 1942, pages 119–132.

Shear Distribution Among Three or More Shear Webs. H. W. Sibert. The distribution of the resultant shear force among the shear webs of a metal wing depends upon the shear stresses due to bending; that is, upon the longitudinal shear stresses and the corresponding equal transverse shear stresses. The variation of shear stress in a leading-edge wing beam was first given approximately by Newell. Subsequently, the author gave a solution for the distribution of shear stress in a metal wing with two or more shear webs.

The shear webs of a metal wing do not carry all the vertical shear force

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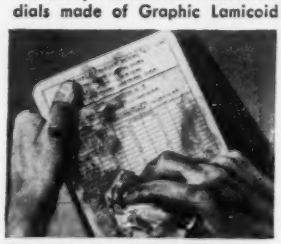

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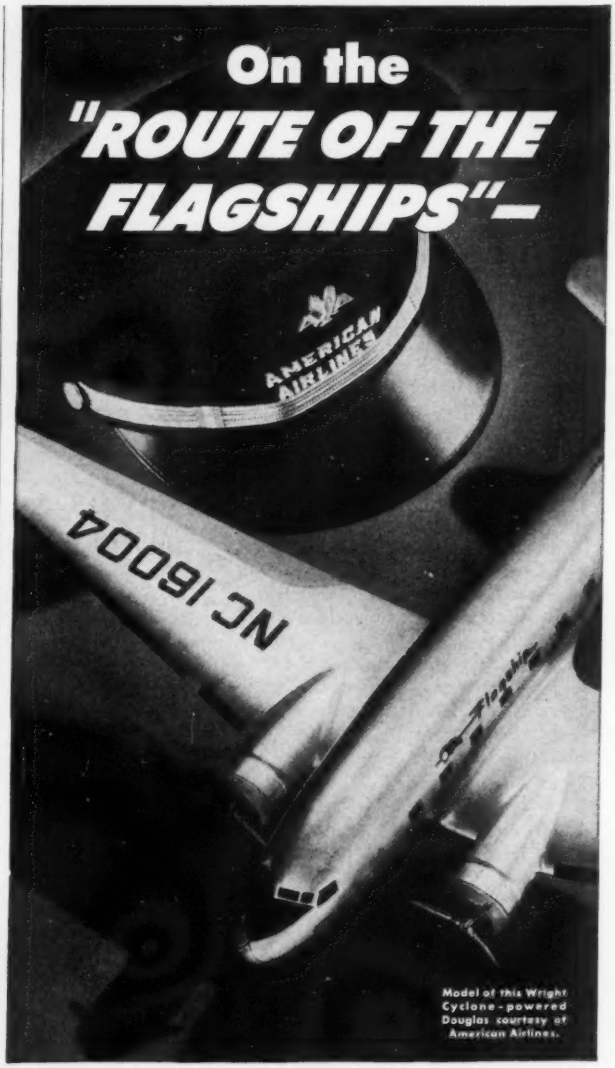

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on the wing because some of the shear load is carried by each segment of the skin that is not horizontal. It would be on the side of safety to assume that the entire vertical shear force on the wing is carried by the shear webs. With this assumption, the distribution of the resultant shear force at any cross-section to two shear webs could be determined from the fact that the sum of these two shear forces equals the resultant shear force, and their moment about any point equals the moment of the resultant shear force about the same point. With more than two shear webs the Principle of Least Work would also have to be employed. The case of three shear webs, based upon the assumption that the shear webs carry all the vertical shear, is worked out in detail and the procedure for a wing with four or more shear webs is then outlined. In each analysis only the case of tension-field shear webs is considered. *Journal of the Aeronautical Sciences*, February 1942, pages 133–134, 2 illustrations.

Facts and Fallacies of Stress Determination. J. O. Almen. It is in machines where weight is all-important, such as in airplane engines, or where weight and cost must both be considered, as in automobiles, that the inadequacy of present means of stress determination and current ignorance of fatigue strength of materials are most keenly felt, the writer of this paper believes. Calculated stresses, he contends, are in themselves meaningless and are of value only when they are interpreted in terms of experience. Although conceding that the accuracy of stress data from photo-elastic and extensometer readings is usually greater than that obtained from the most involved mathematical analysis, it is shown by fatigue tests that these methods are far from reliable.

In the major part of this paper, S-N diagrams with linear and logarithmic coordinates, combinations of the coordinates and three-dimensional coordinates are discussed. The text brings out the effect on fatigue strength of varying degrees of stress concentration; of surface treatment of the test specimens; of stress range.

It is shown that, when fatigue-test results are run on a large number of commercially identical parts over a sufficiently large load range, the scatter of the test points, when plotted on logarithmic coordinates, falls within a well-defined pattern which tends to radiate from a point at high stress and low number of stress cycles and to diverge to a broad band at low stress and high number of stress cycles. *S.A.E. Journal*, February 1942, pages 52–61, 19 illus.

Improvements made on the Vought-Sikorsky VS-300 helicopter include control simplification, now achieved by only two rotors. The tail rotor now acts both as rudder and torque compensator, while longitudinal control, formerly realized by changing pitch on a small rotor at the end of an outrigger arm, is now accomplished through a sectional azimuth changing of the pitch of the main-lifting rotor blades along approximately perpendicular axes.

Tools and Equipment

A Quick and Efficient Method of Making Carbide Tools. Confronted by difficulty in obtaining special tungsten carbide tools, the Buick Motor Division of General Motors has developed its own department for producing such cutting tools at a saving in cost. Carbide tools are produced in this shop by brazing standardized sizes of carbide tips to shanks of SAE 1340 steel. The details of the process for making these tools are described. *Aero Digest*, February 1942, page 141, 3 illus.

Modern Machine Tools. Latest additions to aircraft production tools introduced in British factories. Pictured and described are machines for openside planing, gear hobbing, vertical profiling, heavy-duty turning, slot milling and keyseating, cabinet-type center lathe, and broaching. *Aircraft Production*, January 1942, pages 142–145, 6 illus.

Moulded Press Tools. H. Plucknett. A commentary on the use of plaster and similar materials for small quantity production of press forming tools. Italian fine plaster, 1840 cold-setting resin, Portland cement and Kaffir "EN" are offered as possible alternatives to plaster. *Aircraft Production*, January 1942, page 139.

Fixtures for Checking Aircraft Engine Castings. Herbert Chase. Fixtures are described for speeding up the work of checking and inspecting the complex aluminum castings for the Rolls-Royce Merlin XX liquid-cooled engines, now being manufactured by the Packard Motor Car Company. Some of the castings employed are so complex that, if they were to be checked on the surface plate with ordinary hand gages, it would take a skilled inspector perhaps a week or more to make certain that a given casting comes within the dimensions specified. With these fixtures, it is said to be possible to do in an hour or two work which would otherwise require several days. Methods of using these fixtures are illustrated and described in considerable detail. *American Machinist*, Feb. 19, 1942, pages 127–130, 6 illus.

Training

Russia's A.T.C. A brief account of the activities of the *Ossoaviakhim* in training Russia's youth for service with the air forces. The organization is responsible for bringing the masses of the country's population into contact with aviation and its military aspects—a valuable psychological armor against the shocks experienced by the civilians under conditions of modern air warfare. Though the standard of training is alleged to be low, the *Ossoaviakhim* is not a military organization and its chief importance lies in the fact that millions of young Russians passing through its ranks is in itself a primary contribution to Russia's air potential. *Flight*, January 22, 1942, pages 70a–70c, 6 illus.

School Directory. An alphabetical listing of the personnel and stations of the aviation training schools oper-

ated in the United States. Hundreds of operators and small schools offering flight instruction are omitted from this listing since free lists of all approved flying and ground schools may be obtained from the Civil Aeronautics Administration. The courses offered by those schools here listed are indicated in code. *Aviation*, February 1942, pages 222, 225.

Use Our Idle Schools! Jennings Randolph. A proposal is offered for the enlistment of private trade schools at Government expense to be used in training much needed aviation mechanics. The plan emulates that under which a number of private flying schools have been contracted by the Government for the training of military pilots. *Flying and Popular Aviation*, March 1942, pages 42–44, 5 illus.

Escuelas Elementales y Superiores de Pilotaje Organizacion de las Masmas (Elementary and Advanced Courses for Student Pilots, and Organization of the Schools). O. E. Muratorio. The steady progress of aeronautics makes an intensive training of pilots for civil aeronautics a necessity, according to this writer who offers a detailed study presenting a plan for the organization of schools where the elementary principles of piloting are taught, and for the organization of schools for advanced students. *Aeronautica Argentina*, October 1941, pages 2051, 2052, 2054, 2058, 2060, 2064.

Military Pilot Training. A detailed report of the training procedure being followed at the three branches of the Air Corps Training Center designated as the Southeast Air Corps Training Center, the West Coast Air Corps Training Center, and the Gulf Coast Air Corps Training Center. In addition to explaining how the centers function, something about the men responsible for them, and their place in the military program, the article follows the neophyte through a typical day of training. *Air Facts*, February 1942, pages 19–41, 18 illustrations.

Warfare

Speed Attacks in Daylight. Comair. A study of three basic methods for daylight bombing attacks: high level flying, as exemplified by the Flying Fortress technique, high speed operation at moderate levels, and low-level attack at pursuit speeds. The highest level of attack, the article points out, while it is relatively the safest, pays for this in terms of lowered accuracy and bomb efficiency. High speed, moderate level bombing could, the article continues, have its effectiveness greatly enhanced by some means of assisted take-off.

The third technique suggested calls for a two-place high speed airplane, carrying a single, large bomb to a single, specific objective at a speed of over 400 m.p.h. and at an altitude of between 20 and 200 feet. The special technique for take-off, avigation and bombing required for this type of operation is explained. *Aeronautics*, January 1942, pages 20, 21.

"Forewarned is Forearmed." A. C. Trinder. A description of the observations and organization of the Royal Observer Corps, which is called the "eyes and ears" of the R.A.F. fighter command. *The Aeroplane*, January 23, 1942, pages 105–107, 3 illus.

The Emperor's Airmen. Charles Healy Day. Through years of first-hand observation of the Japanese air force, this writer is convinced that the Japanese have been underrated but are far from world beaters. They not only know how to produce good fighting and bombing aircraft, but they can fly them and fight them better than we have given them credit for. However, they are fundamentally "regimentalists," lacking the initiative and ability to meet unexpected situations as well as their antagonists.

They are skilled in copying equipment and are shown to have provided themselves with American-type bomb sights and Messerschmitts. The writer reviews some of the national and racial traits of the Japanese as applied to their ability as builders and operators of military aircraft. *Air Trails*, March 1942, pages 10–11, 51–52, 4 illus.

Coastal Command. J. C. Trewin. A history and description of the Royal Air Force Coastal Command, explaining its function, equipment and purpose and relating such incidents as the shadowing of the *Bismark*, the capture of the *Altmark* and similar exploits. *Aeronautics*, January 1942, pages 39–41.

Boss of the Big Bomber. Barrett McGurn. A career biography of a typical U.S. Army Air Force's technical sergeant who is in charge of the maintenance crew of a Flying Fortress. Besides being responsible for the mechanical conditions of the aircraft, this non-commissioned officer also acts as flight engineer on actual missions. The article outlines the education of the technical sergeant, also of the other commissioned and non-commissioned officers who make up the crew of the Flying Fortress. *Popular Science*, January 1942, pages 90–95, 13 illus.

La Guerre Aerienne 1914–1941 (Aerial Warfare 1914–1941). R. Dumas. The concluding installment of a comparative study of aerial warfare during World Wars I and II. The writer compares the airplanes used, the tactics employed and the results obtained. He concludes that the way war is waged today the airplane no longer serves humanity, but annihilates it; further that man may be forced to renounce war forever, so that the airplane may become "the dove which carries the olive branch on earth." *Schweizer Aero Revue*, September 1941, pages 6, 7, 2 illus.

War in the Air. James R. Young. A survey by a war correspondent with thirteen years service in Japan. this article summarizes America's position in the war in the Pacific. Discussing air operations and enemy engagements, the writer reports the significant events in the war to date and emphasizes that the activity in the Pacific "has already done much to rewrite most of the preconceptions about aircraft vs. seapower." Numerous pictures illustrate air activities of all fronts from the Far East to continental Europe. *Flying and Popular Aviation*, March 1942, pages 14–23, 60, 62, 71, 73, 74, 50 illus.

Sportvliegtuigen in den Oorlog (Utilization of the Light Airplane in Warfare). Leo Van Straaten. Observations on the possibilities of light airplanes in warfare. Special attention is drawn to the results shown during the U.S. Army maneuvers in Texas and North Carolina. Great maneuverability, the ability to fly low and slow, to take-off and land on a very small area, and to be parked on almost any open space make the light airplane an ideal medium for liaison and observation. *Vliegwereld*, October 16, 1941, pages 590, 591, 2 illus.

Escapes. An account of bombers that have come home in defiance of all the laws of aviation and of the crews who flew them under conditions of incredible difficulty. It tells of the exploits of pilots, gunners and wireless operators who survived some of the most harrowing experiences in military aviation and pays tribute to the excellence of the design and construction of their aircraft, which made possible their return over miles of hostile territory and the sea. *The Royal Air Force Quarterly*, December 1941, pages 27–34, 5 illus.

America at War. A general statement on the position of the American

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air services in the Pacific, this article quotes the Chief of the Air Forces as saying that the A.A.F. has been called upon "to meet so many different missions in so many different theatres of war, with such an extreme disparity of equipment." Elaborating on this comment, it is indicated that Japan's superiority in the air rests mainly on numbers. One lesson learned, it is said, is the difficulty in recognizing enemy aircraft and our own under war conditions. *Aviation*, February 1942, pages 78, 79, 305, 3 illus.

Welding

The Function of Contact Resistance in Spot Welding. R. F. Tylecote. This discussion is confined to the aspects of contact resistance in spot welding of metals, noting that in the aluminum alloys the resistance is chiefly caused by the presence of an oxide film on the surfaces of the metals. The nature of contact resistance is outlined, with studies of the physical properties and the effects of pressure, surface condition and temperature. Observations are made on the changes of resistance during the welding cycle, accompanied by numerous charts and tables.

It is concluded that in the case of ferrous materials, interfacial contact resistance does play a definite part in the formation of the weld, especially when the stock is rusty or scaly, in which event pickling should be resorted to. On the other hand, there is no evidence so far to show that the resistance of the film plays a part in the spot welding of aluminum and the light alloys at normal operating pressures, or at any rate not so much as to influence the strength of the weld obtained.

It is suggested that the electrode contact resistance should in all cases be kept to the lowest possible values, which can be brought about by high pressure, cleaning and pickling, and possibly by the method suggested by Schmitt and Wulff. *The Institute of Welding*, Quarterly Transactions, July 1941, pages 154–165, 20 illus.

Spot Welding Can Be Successfully Used for Stainless Steel Aircraft. Carl De Ganahl. The vice-president of Fleetwings, Inc., relates the experiences of his company in applying the theory of welded stainless steel structures to the building of aircraft. The article outlines the basic theory of spot welding as applied to stainless steel, describes the equipment that has been developed in the last ten years for this type of aircraft construction and presents the operational methods applied in several typical subassemblies and accessories. Some material on the spot welding of aluminum alloys is also given. *Sheet Metal Industries*, December 1941, pages 1555–1557, 1562, 3 illus.

Adjusting an engraving machine in the electrical sub-assembly department of the Inglewood plant of North American Aviation. The operator, Elfie Hendricks, is believed to be the only woman operating this type device.

Wind Tunnels

Variable Speed Drive Wright Field Wind Tunnel. A. M. Dickey, C. M. Laffoon and L. A. Kilgare. An account of various problems which arose in the design of suitable driving power for the wind tunnel at Wright Field, this article describes the variable speed unit finally selected and explains the starting and operation of this equipment which is said to be the largest induction motor yet built. A number of problems confronted in the application of this system of speed control are pointed out and it is said that their solution had led to some advances in the analysis of machines and in the design of very large motors. *Aero Digest*, February 1942, pages 212, 216–218, 2 illus.

Miscellaneous

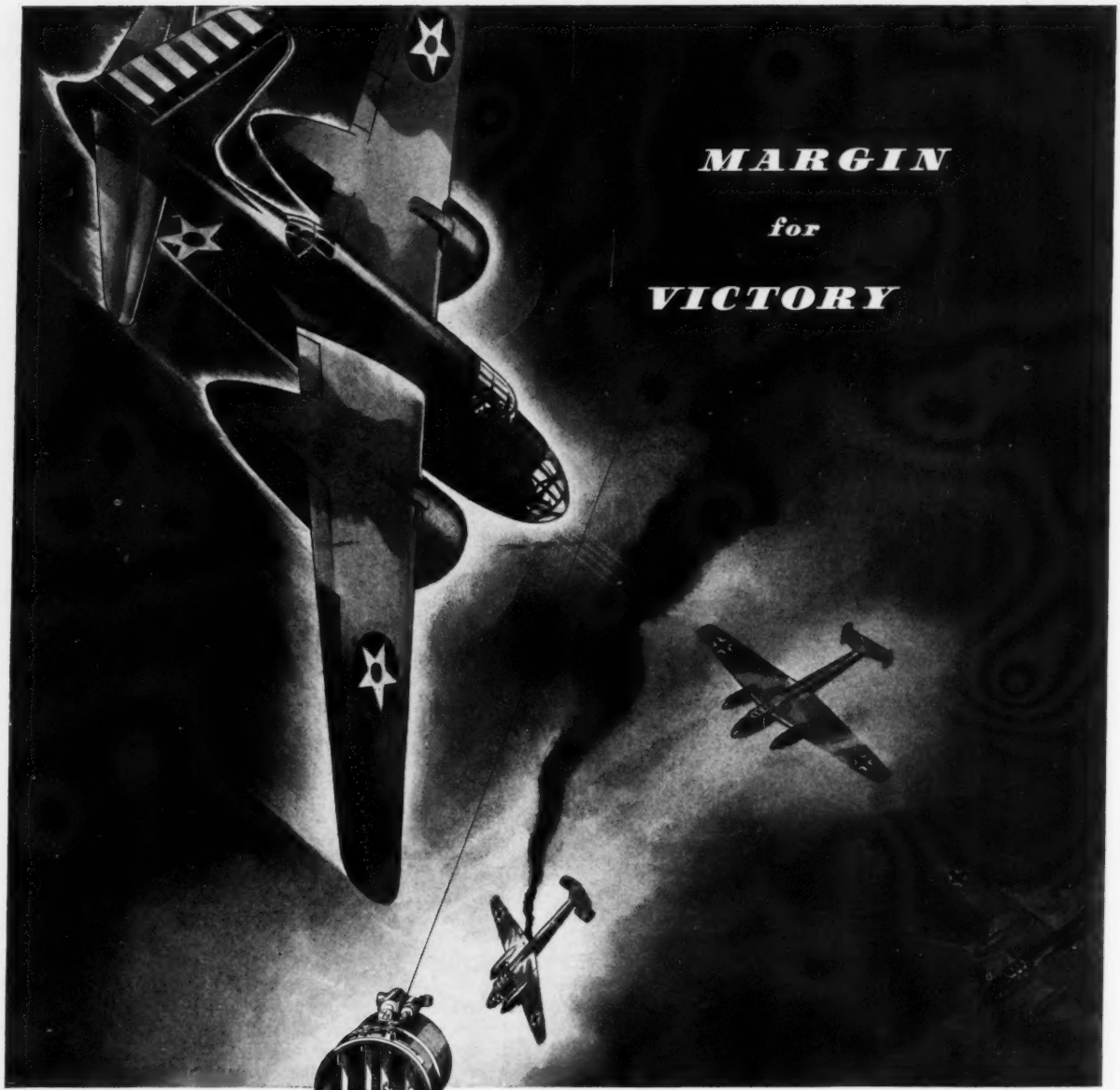
Air Film Flashes. J. R. Harmer. A bibliography of the important motion pictures filmed since January 1935, giving the date of release, the producing company, feature players and a brief résumé of the plot. Some of the outstanding films of the previous decade are also mentioned. *Aeronautics*, January 1942, pages 50–54, 16 illus.

1941—A Diary of the Aeronautical Events of the Year. A chronology of events of aeronautical importance throughout the world. *The Aeroplane*, January 2, 1942, pages 22–24, 6 illus.

From the Fight to the Factory. A review of the benefits to be derived from close cooperation between the men who do the fighting and the men who build the airplanes. It is concluded that production in aircraft factories goes up when the men who fly their products visit the men who build them. A greater understanding is accomplished on both sides as to the special problems of each, with the result that each man's job bears greater significance to him as a result of the contact. *Aviation*, February 1942, pages 80, 81, 306–308, 5 illus.

Against the Fire Menace. Marc Hanlon. A description of a new agent for instantly extinguishing magnesium fires in defense plants. It is described as harmless to either the human body or the most delicate machine, and is composed of a combination of several viscous liquids and carbon dioxide. *Western Flying*, February 1942, pages 41, 42, 5 illus.

How to Minimize Damage from Bombs. An explanation of the primary and secondary effects of bomb explosions. Definitions are given for the six common types of aerial bombs —demolition, fragmentation, gas, incendiary and armor-piercing bombs, and aerial mines. The effects of bomb explosions on various types of building construction are shown and methods are suggested for protection of life and property. *Factory*, January 1942, pages 106–107, 1 illus.



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Government Publications

U.S. Army Air Forces

U.S. Tigers Claw Japs. An account of Brig. Gen. Claire L. Chennault's formation of a volunteer unit of American pilots with the Chinese Air Force in defense of the Burma Road. This article gives a brief outline of General Chennault's career in the U.S. Army and the formation of the now famous "Flying Tiger" unit which is fighting the Japanese in Indo China and along the Burma Road. The formation, selection and training of this squadron, and the special conditions under which they operate are described. *Air Forces News Letter*, February 1942, pages 1, 2, 8, 2 illus.

A German View of Japanese Air Power. A discussion of an article from the German magazine *Seemacht* on the strength of the Japanese Air Force. The article relates how the Japanese Air Forces were created under the influence of French, German and American experience, and how their organizations have been influenced by the instructors from various countries. Also described are some of the aircraft, the tactics and the philosophy which motivate Japanese air power. *Air Forces News Letter*, February 1942, pages 9–11.

British Reveal Observers' Technique. Air Commodore H. LeM. Brock. The Vice-Commander of the Royal Observers Corps explains the system by which aircraft spotters in England have been trained to recognize British and enemy aircraft in order to facilitate more effective spotting and anti-aircraft observation. The use of recognition cards and silhouettes for notices and motion pictures for advanced observers is outlined. *Air Forces News Letter*, February 1942, pages 15, 16, 39.

"Flight Strips" for Dispersion of Aircraft. Lieut. Col. Stedman Shumway Hanks. The defense highway act of 1941 authorized the construction of "Flight Strips" along highway rights-of-way and other publicly owned land. This article indicates the importance of these flight strips in the dispersion of aircraft for national defense and as auxiliary bases in case of attack. *Air Forces News Letter*, February 1942, pages 17–19, 2 illus.

The Cruise of the Arabian Night. Lieut. Col. Caleb V. Haynes. A description of a special flight to and fro n the Middle East in which Maj. Gen. George C. Brett, Chief of the Air Corps, and his staff made an inspection trip. The article relates the selection of the crew and the events of the flight across the South Atlantic through Egypt, cutting around hostile territory to Cairo, the Middle East, Europe and back. *Air Forces News Letter*, February 1942, pages 23, 24, 40.

180 Miles without a Motor. Lieut. Claude L. Luke. An account of a soaring flight from the Army Glider School at Elmira, New York, to a flying field near Fort Dix, New Jersey, a distance of 180 miles. This constituted a new long distance record for army glider pilots. *Air Forces News Letter*, February 1942, pages 25, 26, 40, 1 illus.

New Committee Develops Design Criteria. An exposition of the functions of the Army-Navy-Civil Committee to coordinate the development of aircraft design criteria. It was established jointly by the Secretaries of War and Navy and the Administrator of Civil Aeronautics. The account lists the functions of the committee and the twelve subcommittees which will lay out the design criteria program and investigate and report the progress of the committee of the member branches of government. *Air Forces News Letter*, February 1942, page 36.

Congress of the United States

Additional Report of the Special Committee Investigating the National Defense Program. This document is the complete transcription of the much discussed Truman report submitted to the Congress of the United States and ordered printed January 15, 1942. It includes a chapter on production from the facilities of accepted military aircraft manufacturers, from similar aircraft manufacturers and subcontractors and a survey of the aircraft training program. This report contains the criticism of United States pursuit aircraft which has caused considerable dispute between members of the Government and representatives of certain aircraft manufacturers recently. *U.S. Senate, Report No. 480, Part 5*, available through the Government Printing Office, Washington, D. C., 288 pages.

National Advisory Committee for Aeronautics

Twenty-seventh Annual Report of the National Advisory Committee for Aeronautics. The general administrative report of the National Advisory Committee for Aeronautics submitted to the President of the United States in compliance with the provision of the act of Congress, March 3, 1915. The report outlines the problems affecting the character and scope of aeronautical research which the committee has investigated and indicates the extent to which research facilities have been expanded during the past year.

The work of the general technical remedies during the year is indicated in the report, and the organization and general activities of the committee on such projects as aeronautical inventions, coordination of research and industrial cooperation are outlined. Members of all special committees and subcommittees are named. *N.A.C.A. Administrative Report*, submitted December 15, 1941, 14 pages; available through the Superintendent of Documents, Washington, D. C., $0.10.

Contribution to the Ideal Efficiency of Screw Propellers. Wilhelm Hoff. Translation of an article entitled "Bermerkungen zum idealen Wirkungsgrad von Schraubenpropellern," from *Luftfahrtforschung*, April 22, 1941. The stipulation of best thrust distribution is applied to the annular elements of the screw propeller with infinitely many blades in frictionless, incompressible flow and an ideal jet propulsion system derived possessing hyperbolic angular velocity distribution along the blade radius and combining the advantage of uniform thrust distribution over the section with minimum slipstream and rotation losses. This system is then compared with a propeller possessing the same angular velocity at all blade elements and the best possible thrust distribution secured by means of an induced

efficiency varying uniformly over the radius. Lastly, the case of the lightly loaded propeller also is discussed. *N.A.C.A. Technical Memorandum No. 1002*, January 1942, 25 pages, 12 illus.

Civil Aeronautics Administration

Federal Airways Manual of Operations. A new manual of radio operations, *The Nation's Airways*, issued to supersede the previous publication and supplements, became effective as of February 15, 1942. It contains a list of identifications and radio call letters, the operating abbreviations now in use and a complete listing of all call letters and stations now in service on the airways system. *Civil Aeronautics Authority, Airways Division*, February 1942, 61 pages.

Anoxia, Hyperventilation and Medical Standards For Pilots. Excerpts from a recent paper entitled "Medical Problems in Aviation" prepared by Dr. H. Corwin Hinshaw and Dr. Walter M. Boothby of the Mayo Foundation. These contain information for pilots on how the lack of oxygen or fast and deep breathing might affect their safety. The subject of anoxia and hyperventilation is explained and the general medical standards for pilots are outlined. *C.A.B. Safety Bulletin*, 3 pages.

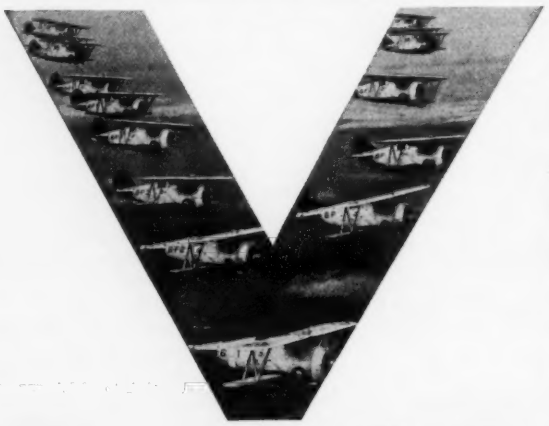
Formula for the Establishment of Minimum Limitations for Air Carrier Operations. This formula, issued to Scheduled Air Carriers, Air Carrier Officials, Safety Regulation Inspectors and C.P.T. Maintenance Supervisors, is intended to aid in the establishment of minimum limitations for air carrier operations. It is for use by the industry and inspectors as a guide in establishing minimums, in ceiling and visibility limitations, landing-down-through limitations, instrument take-offs and landings, and similar borderline conditions where the judgment is up to the individual inspector or operator. *Safety Regulation Release No. 85*, December 1941, 10 pages.

Aircraft Lightning Dischargers. This bulletin has been prepared for the purpose of outlining the conditions which are most likely to prevail at flight levels where lightning discharges occur. The booklet points out areas to be avoided in which lightning discharges are possible and procedures for pilots to follow in the event that they are in such regions. *Civil Aeronautics Board Safety Bulletin No. 111*, February 1942, 2 pages.

National Bureau of Standards

The Tee-Bend Test to Compare the Welding Quality of Steels. George A. Ellinger, A. G. Bissell and Morgan L. Williams. A bend test for comparing the welding quality of steels is described in this paper. Specimens of fillet-welded T-sections of a number of low-alloy high-tensile steels were bent in special testing jigs at room temperature and at temperatures as low as —20°F. Several criteria, such as maximum load, angle at maximum load, type and location of fractures, were used to compare the specimens. A special method of statistical analysis, which is described in detail in the paper, was used to evaluate the data and to compare and rate the welding quality of the steels. *Journal of Research of the National Bureau of Standards*, January 1942, pages 1–49, 34 illus.

Rectangular Plate Loaded Along Two Adjacent Edges by Couples in its Own Plane. William R. Osgood. A. and L. Föppl give an approximate solution for the stresses in the rectangular knee of an L-shaped plate loaded by couples acting on the legs in the plane of the plate. A solution is presented here that is exact in the sense that the equations of equilibrium and the condition of compatibility (for two-dimensional systems) are satisfied at every point. Small self-equilibrated stresses remain along the free edges of the knee. *Journal of Research of the National Bureau of Standards*, February 1942, pages 159–163, 5 illus.



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Mechanic's Manual

There are a certain number of questions the average apprentice will probably ask before he arrives at mechanical maturity, and an additional number he will continue to ask for some time to come. This book gives the answer to the most important of these in the simplest possible terms. Applying the question and answer approach, the features of construction and mechanical details of typical modern aircraft engines are presented, along with the terms generally applied in referring to them.

The major components of the powerplant, the magnetos, the carburetor, starter, instruments, propeller, etc., are reviewed in a like manner. The modern variable-pitch propeller is given unusually close examination, and both British and American types are studied.

While this work is British in its origin and much of its terminology, it indicates a marked trend toward a compromise technical nomenclature between the United States and Great Britain.

The Aero Engineer's Manual, by P. H. Simpson, Chemical Publishing Co., New York, 1941, 125 pages, $2.50.

Directory Series

Differing from the two previous editions, this year's *Aerosphere* is divided into three individual volumes making its physical handling considerably more convenient. One is devoted to aircraft of the various major nations, the second to engines and the third to a general directory of aircraft products and services.

The first volume contains in alphabetical order the popular aircraft, both civil and military, of the United States, Britain, Germany and twenty other nations. As far as military restrictions will allow, photographs, specifications, construction details, engine power and performance of the various aircraft are listed.

Besides this information such other matter as model identification of U.S. aircraft supplied to Britain and a key to Army and Navy Air Force designations is provided. Among the other useful lists are the symbols and interpretations of the various types of aircraft used by the Army and Navy.

Power plants manufactured in the United States and fourteen other nations are similarly handled. These include not only the standard well-known engines but some of the less popular and less known experimental power plants which have been built and successfully run. Limited by military restrictions, the general description, specifications, construction and performance of the power plants are given. The appendix of this volume contains in a single set of tables, the principal specifications of modern aircraft engines built in the United States, the British Empire, France, Italy, Russia and many other countries.

The final volume in this series, the *Buyer's Guide*, contains an alphabetical listing of the firms and organizations engaged in aircraft activities. They are listed by country and then subdivided by activities. The particular method of cross indexing is well suited to the location of materials when needed.

The 1942 *Aerosphere* shows a marked improvement over the two previous issues despite the hamstringing effect of restrictions on information. While the general handling of material on engines and aircraft remains basically the same as before, the division of the contents of the three books and the improved classification and indexing make for more convenient handling of this standard work.

Aerosphere, edited by Glenn D. Angle; **Modern Aircraft,** 400 pages, $6.00; **Modern Aircraft Engines,** 240 pages, $3.00; and **Buyer's Guide,** 355 pages, $3.00; Aircraft Publications, New York, 1942.

Aircraft Histories

These two books, one published in the United States and the other in England, complement each other and cover practically every form of air combat. An earlier book, *British Fighter Planes*, would complete the triology. In reviewing the history of combat airplanes, Mr. Grey has used *Jane's All The World's Aircraft*, which he has edited for many years, as a reference. Because of this, some of the speeds, range and other characteristics of aircraft are those furnished by the manufacturers, with obvious variations. To these annual summaries Mr. Grey adds his informative comment which is always interesting if, at times, irritating. The closing chapters of the book, which deal with the developments of the present war, are of the greatest value, as they give an account of the Battle of Britain with as many facts as the censor will allow. In this respect, the American blue pencil seems more generous than the English.

In "Bombers" there is a wealth of typical "C.G.G." reminiscences and the style is that of "discoursive journalism" which may include some of the careless references which that form of writing exemplifies.

The development of bombers until the armistice of the first World War, the progress made during twenty-five years of peace and the improvements that have come from the experience of the present war are the principal divisions of the text. To this is added "Aerobiographies" which give sketches of English and American aircraft companies.

The temptation to write a critical review is great, as it would be so easy to correct slips of the pen or dispute what is often stated as facts, but Mr. Grey is so well known by American aeronautical readers that he is read for his brilliant style, encyclopedic knowledge and amusing stories rather than for ex-parte accuracy. As he has to rely principally on correspondence for his intimate information regarding American aircraft and people in the United States, it is natural that his memory fails him at times, but in spite of these annoying lapses, the books give the most comprehensive surveys yet made of the use of warplanes. Those who have been readers of "C.G.G." in *The Aeroplane*, will find just what they expect and enjoy, a readable account of the weapons which will win the present war.

Bombers, by C. G. Grey; Faber and Faber Limited, London, 1941; 252 pages, 6*s*.

The History of Combat Airplanes, by C. G. Grey; Norwich University, Vermont, 1942; 158 pages, $1.00.

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Predicting Lightplane Performance

This addition to the Cadet Series of aviation texts offers a simplified method of predicting the performance of a light airplane during the process of design. The method is based on three cardinal principles. These are that the design must emanate from sound aerodynamic and mechanical principles, that the designer must have a definite goal or purpose for the design in mind, and that he respect the limitations as well as the possibilities of the design involved.

The method of approach takes for granted that the reader has a certain mathematical as well as aerodynamic background. Yet, the mathematics used in the presentation of the subject are simplified wherever possible without jeopardizing the mathematical accuracy of the method propounded.

Light Aircraft Performance Calculations, by Juan Klein Serralles; Aviation Press, San Francisco, 1941; 67 pages, $2.00.

Plywood Encyclopedia

The reappearance of plywood as a first-line aircraft material is a natural result of metal shortage. Some writers point out that the objection to plywood in aircraft construction raised over a decade ago was never applicable to the material itself but rather to its bonding agents.

The introduction of synthetic-resin adhesives and other improvements endowed modern plywood with certain advantages which have brought it back into the limelight of structural materials. It is important therefore that a goodly part of the technical data on plywood be mustered in one place for quick reference. This book was written for that purpose by one of the foremost specialists in plywood development.

The chapters show the intensely practical nature of the author. Instead of the usual placement of the glossary at the end, the listing of trade terms used in the plywood industry is put on page one, so that the reader knows what the author is writing about. This is followed by a brief history of the material which dates back to the Egyptian civilization. From this point on the information is intensely practical. It discusses first the economical and structural advantages of plywood over other types of wood and other types of material, indicates how it conserves timber and turns wood into a more flexible structural medium, and shows the nature and composition of plywood adhesives popularly used in aircraft construction.

The characteristics of plywood, its manufacture, the various processes and application to industry are presented, with a fair-sized section devoted to its aircraft applications. Among the most valuable contributions to engineering material are the last three sections of the book which collect in one place most of the necessary tabular data on plywood, such as plywood and veneer thickness, cost tabulation, moisture content data and the like, the rules for grading veneer and tests for adhesive strengths.

Modern Plywood, by Thomas D. Perry, Pitman Publishing Corporation; New York, 1942; 366 pages, $4.50.

Oxygen Starvation

The effect of oxygen want on the body is an important consideration in the building of airplanes and the altitudes they may be expected to attain. This is a systematic account on the relation of anoxia to all known physiological processes of the body.

It reviews in detail the effect of anoxia on the blood, heart and circulation, and on the blood pressure, lymph, and respiration. The chemical changes in the body produced by anoxia are pointed out as well as the symptoms and causes of mountain and altitude sickness. Acclimatization, effects of anoxia on the alimentary tract, on the secretion of the kidneys, and on the endocrine glands are covered. The author also examines anoxia's relationship to oxidative and nitrogen body metabolism, nutrition, heat regulation, water distribution of the body, and the nervous system.

Anoxia, Its Effect on the Body, by Edward J. Van Liere; The University of Chicago Press, Chicago, 1942; 269 pages, $3.00.

Transport Progress

A picture of the development of commercial air transportation in the United States, the growth and extent of Federal regulation concerning it, and the problems and services of the airlines. Basing his thesis on an examination of policies and regulations concerning the industry to date, the author also ventures some predictions of developments that may be expected in the future.

The book does not confine itself to an intensive study of any one phase of the subject but endeavors to give a complete survey of all topics. It includes discussion of airport development, adequacy of feeder airlines, airline equipment and operation as well as airline financing, selling and promotion of air travel. Considered, too, are air express development, managerial problems of air cargo transportation and air-mail traffic rates under the C.A.A.

Commercial Air Transportation, by John H. Frederick; Richard D. Irwin, Inc., Chicago, 1942; 493 pages, $4.00.

Student's Omnibus

This is one of the first attempts at a complete omnibus of flying for students. It covers all material required for private and commercial pilots' licenses, conforming to the courses set up by the Civilian Pilot Training programs. Frequent use is made of photographs and line drawings to supplement the written explanations and each basic principle is tied in with its application to the particular type of flight problem or procedure.

The first two parts of the book are on Aircraft and Theory of Flight, and Aircraft Engines. Meteorology and Air Navigation are the subjects of the third and fourth parts. The student flyer will probably find particularly helpful the practice of explaining each new aviation term as it makes its first appearance in the text.

Air Pilot Training, by Bert A. Shields; Whittlesey House, New York, 1942; 602 pages, $4.00.

Mechanics' Pocket Reference

This sixth edition of a standard work containing the general information required by aircraft factory workers, offers first the fundamentals of aircraft construction such as layout, operations and nomenclature. A study of aluminum and its alloys, formulas, treatment, machining, forming, riveting, and other operations follows. Aircraft steels are similarly handled.

Other sections of the book are devoted to actual assembly, riveting, and installation methods used in the average plant. Simplified plane geometry as applied to the aircraft worker's task, sketching, dimensioning, and notes on the reading of blueprints are also offered along with a glossary of common terms and the most frequently used charts and formulas.

Standard Aircraft Workers' Manual, published through Fletcher Aircraft Training System; Burbank, California, 1941; 145 pages, $1.50.

Production Planning

This book has been written for two groups of readers: executives and others concerned with daily problems in industry, and students of industrial management and engineering in colleges. It is the second book on the subject, the first having been issued in 1930, since which time increasing attention has been given to the science underlying the processes of manufacture.

Throughout the book, care has been taken to state plainly the underlying principle or law for each step in the control of a work routing program, showing how these fundamentals are put into everyday practice. Among the subjects treated are the analysis of operations, proper quantities to put through economically, centralized planning, quality control, the problems of tools, dies and fixtures, material handling, and the laws of movement and rhythm in industry. Cost accounting, standardization, company policies, personnel and other problems are covered, explanations being given of the use of charts and forms. Problems at the end of each chapter serve to summarize the information covered and give the reader an opportunity to test the degree of his absorption of the subject matter.

Work Routing, Scheduling and Dispatching in Production, by John Younger and Joseph Geschelin; The Ronald Press Company, New York, 1942; 160 pages, $3.25.

Who's Who

The 1942 edition of the useful reference book adds greatly to the growing need for correct information about people and organizations in the aeronautical field.

The "Who's Who" section will be particularly helpful, as it gives biographical sketches of many persons who are active in aeronautical affairs but are not listed in other reference books. As a handy guide to the aircraft industry and the products made, *The Blue Book* is taking its place as one of the standard reference books needed to be kept within arm's reach.

The Blue Book of American Aviation, edited by J. Alfred Miller and George J. Searle; The Aviation Statistics Institute of America, North Carolina, 1942; 242 pages, $3.00.

Gliding and Soaring

An entertaining plea for youngsters, not yet old enough to fly motored planes, to learn gliding and soaring. With descriptions of methods, equipment, past achievements, design advances and military uses, its avowed purpose of stimulating interest in these activities for boys is followed.

Gliding and soaring, the author points out, is a comparatively inexpensive method of preliminary instruction for young men who wish to become aviators. It qualifies them for more rapid training in military and commercial aviation. Therefore, he concludes, it is an important adjunct to our war and defense efforts and should receive the encouragement of everyone.

Youth Must Fly, by E. F. McDonald, Jr.; Harper & Brothers, New York, 1942; 221 pages, $2.50.

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Air Power Survey

A series of picture studies of the types of aircraft now engaged in the world-wide military conflict are presented from the British point of view. Most of the booklet is devoted to photographs of the Royal Air Force and Fleet Air Arm types, including the Hurricane, Spitfire and Devastator. Many other pursuit and bomber types being used by the British, the United States, Germany and Italy are also shown. Reproductions of the badges of rank for R.A.F. officers and of the decorations made specifically for service in the air are included.

Part of the text is given over to special functions of the airforces, with explanations of the techniques used by torpoedo carriers, photographic airplanes and other specific types. Some of the widely known oil paintings, such as C. E. Turner's paintings of the Skua attack on Bergen airport and the attack on the Dortmund canal, are reproduced.

British Airforces; Illustrated London News; London, 1941; 40 pages, 3*s*. 6*p*.

Magnaflux Manual

This manual is intended to be a service handbook for the Magnaflux method as used to inspect aircraft and engine parts in both their manufacture and maintenance. It is a workmanlike presentation of the history of the process, its basic theory and its application to the specific inspection problems.

After a brief introduction to the background and use of the Magnaflux system, the basic physics of magnetism and its connection with the system are explained. The magnaflux equipment and method are reviewed and specific applications of the system to various parts of the airplane are outlined.

The bulk of the work is devoted to detailing the variations in technique as applied to different problems, and to the recognition and interpretation of Magnaflux indications. The book closes with photographs of typical defects and Magnaflux indications.

Magnaflux Aircraft Inspection Manual, by F. B. Doane and W. E. Thomas; 2nd edition, Magnaflux Corporation, Chicago, 1941; 193 pages, $1.75.

Development of Aviation

Written in a style that can be easily enjoyed by adolescents but providing an equal fund of knowledge for adults is this story of the development of aviation. Its colorful presentation stems from the accurate information of two well-known newspapermen aided by the editing of an authoritative historian.

How aviation began; who did it; what is behind it; and why we are building the most powerful air force in the world . . . are some of the questions this book seeks to answer. Sections are devoted to the tracing of airline flights, the history of aviation, exploits of noted flyers, soaring and gliding, aircraft radio, and the airplane for both peacetime and military operation. A chronology of aeronautical events appended to the back of the book provides a quick and handy reference.

The Wonder Book of the Air, by C. B. Allen; The John C. Winston Company, Philadelphia, 1941; 340 pages, $2.50.

The R.A.F. Strikes

While this work, the official account of the Royal Air Force Bomber Command's action against the Axis, is the Air Ministry's version of what happened and must be taken with the appropriate degree of consideration, it does reveal for the first time under a single cover the technique, strategy and operating progress of this division of the R.A.F.

The contents, while for the most part slightly *dressed* presentations of official reports, relate dramatically the action of this unit from the first attacks on the German fleet, the leaflet raids over Europe, the heartbreak in Norway, the forays on Italy and Flanders to the smashing of the invasion armada during the early summer of 1941.

In various articles, from time to time, many of the events covered in this book have been discussed, sometimes in even greater detail. This presentation differs in that it is complete and authorized, the government's own version. It contains more than the facts. It contains some of the heartbreak, the trials and the sweat that go into the task of flying to an objective in constant peril; not the exploits of one man, but of a trained team who submerge their personalities for the sake of having even a minute part in the major objective.

Bomber Command; Doubleday, Doran & Company, New York, 1941; 128 pages, $1.00.

Book Notes

Wings Around South America, by Alice Dalgliesh; Charles Scribner and Sons, 1941; 158 pages, $2.50.

A personalized account of an air tour through ten republics of South America.

Flying with the C.A.A., by Lewis E. Theiss; W. A. Wilde Company, Boston, 1941; 303 pages, $2.00.

A fictional account of three American schoolboys who complete the Civilian Pilot Training Course, take advanced training for Army, Navy and C.A.A. instructors, and uncover a sabotage plot in a defense project.

Hostess of the Skyways, by Dixie Willson; Dodd, Mead & Company, New York, 1941; 352 pages, $2.00.

One of the Dodd, Mead career series, this work explains the career of air hostess to young women preparing for this profession.

Machine Shop Theory and Practice, by Albert M. Wagener and Harlan R. Arthur; D. Van Nostrand and Company, New York, 1941; 306 pages, $2.28.

A text designed for beginners in the study of machine tools and their operation.

Aviation Cadet, by Henry B. Lent; The Macmillan Company, New York, 1941; 176 pages, $1.75.

An account of a typical student's career in naval aviation, from his preliminary training at Floyd Bennett Airport in New York to his graduation as a naval aviator at the Pensacola Air Station.

Bamboo to Bombers, by Stanley Washburn; Albert Whitman & Company, Chicago, 1941; 82 pages, $1.00.

A children's illustrated history of aviation from da Vinci's ornithopter to the Douglas B-19.

College Physics, by A. Wilmer Duff and Morton Masius; Longmans, Green and Company, New York, 1941; 588 pages, $3.80.

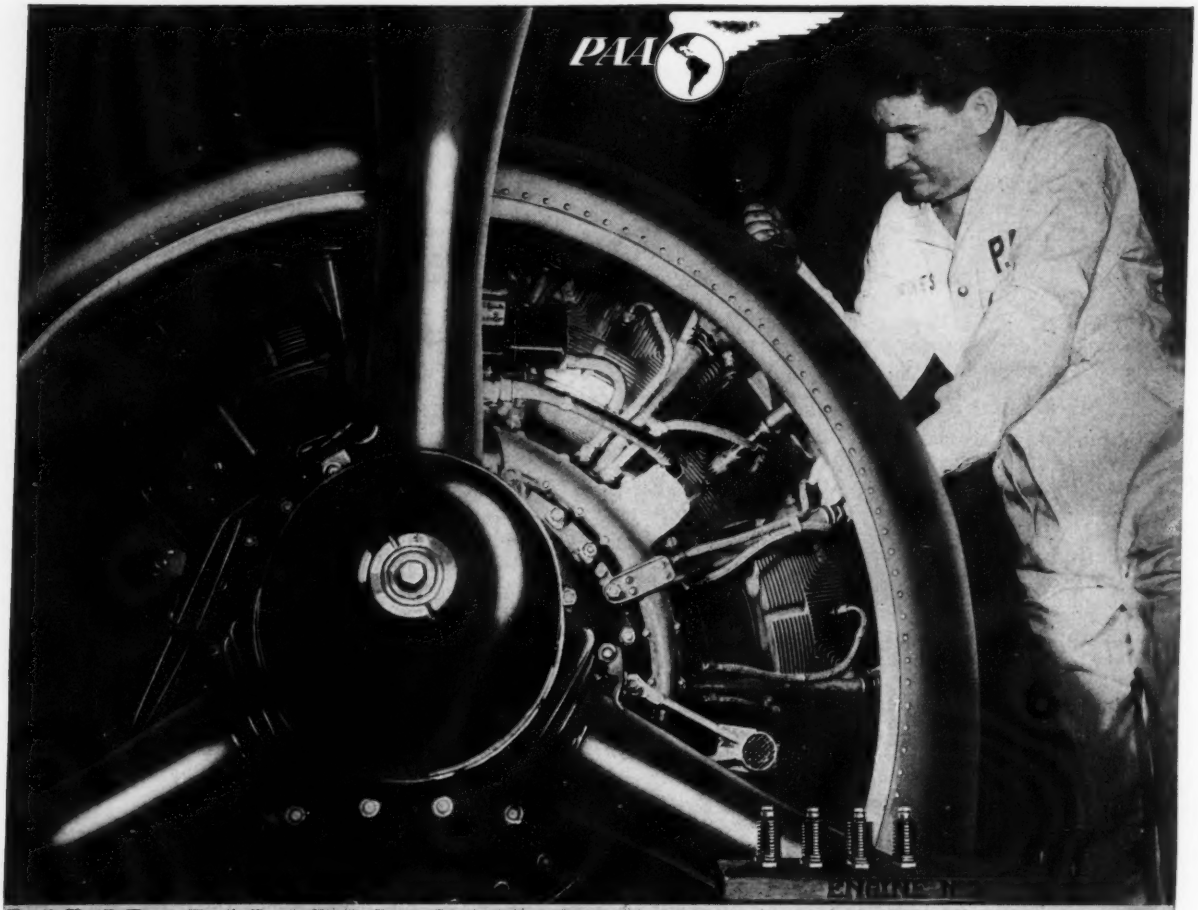
An exposition of the fundamentals of physics suitable for advanced study in physics and engineering.

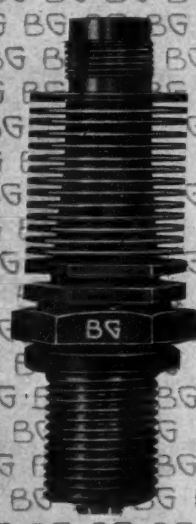
The New Alphabet of Aviation, by Edward Shenton; Macrae-Smith Company, Philadelphia, 1941; 58 pages, $1.75.

A list of aeronautical terms illustrated and explained for a junior audience.

Molding Technic for Bakelite and Vinylite Plastics; 4th edition, Bakelite Corporation, New York, 1941; 224 pages, $3.50.

A revision of the standard handbook on the art of molding bakelite and vinylite, giving the principles of molding, the application of material, the basis of mold design and equipment, and other basic information required for the successful use of molding plastics.





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mechanic installing BG Spark Plugs in a Wright Engine. BG's have always been standard equipment on Pan American Airways Planes.

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Index to A.S.T.M. Standards Including Tentative Standards; American Society for Testing Materials, Philadelphia, 1941; 188 pages.

A December 1941 issue of the American Society for Testing Materials specifications, methods of testing, recommended practices, definitions of terms, charts and tables. Includes an alphabetical arrangement according to the significant word in each title and numerical sequence of A.S.T.M. Serial Designations.

Fighter Pilot, by Paul Richey, Charles Scribner's Sons, New York, 1941; 178 pages, $2.00.

A personal narrative of the R.A.F.'s battle in France, written by a twenty-five year old veteran of the campaign.

Aeronautical Training, by Charles A. Zweng, Pan American Navigation Service, Glendale, California, 1941; 191 pages, $2.00.

A recent revision of one of the standard quiz systems for commercial and private pilot training. Intended for C.A.A. examination preparation on navigation, meteorology, aircraft, power plant study as well as air commerce regulations and traffic rules.

Ribbons and Medals, by Capt. H. Taprell Dorling; George Philip & Son, Ltd., London, 1940; 177 pages, 6*s.* 6*d.*

A pictorial and descriptive guide to recognition of British ribbons and medals. Covers naval, military, air force and civil honors bestowed on His Majesty's forces by native and foreign orders. Enlarged and revised edition, published in 1940.

Medical Organisation and Surgical Practice in Air Raids, by Philip H. Mitchiner and E. M. Crowell; The Blakiston Company, Philadelphia, 1941; 296 pages, $3.25.

This book deals with the organization of medical establishments and the accepted treatment of the types of wounds which may be expected in air raids. In relation to the problem of administration, problem descriptions are given of the different posts in the line of evacuation, the functions of each, and advice on what is wanted, where to put it and what to do. The technique of wound treatments is based on surgical experience in the first World War, in China and in Spain.

Blueprint Reading, by Arthur A. Dick; The Ronald Press Company, New York, 1942; 157 pages, $2.40.

A visualization method of instruction in blueprint reading. The introductory section of this text, covering general information, terminology and symbols, prepares the student for the problems and assignments to which its major portion is devoted.

Tom's Book of Flying Models, by Paul K. Guillow; published by the author, Wakefield, Massachusetts, 1941; 32 pages.

This is an illustrated explanation of the methods used to build flying models. Among the subjects depicted are two ways of cutting Balsa parts, two methods of building fuselages, nine of wing construction, and three of installing rubber motor. Three kinds of cement joints and four kinds of pinning are shown. Suggested, too, are short cuts in building side frames, easy means of covering curved surfaces, and a simple way to locate wing position on round body.

The British Commonwealth Air Training Plan, by I. Norman Smith; The MacMillan Company of Canada Limited, Toronto, 1941; 28 pages, $0.25.

Complete details of how the British Commonwealth Air Training Plan functions, its history, cost, and the success it has achieved. This pamphlet also discusses the part played by the pilot, the gunner, the observer, and civilian cooperation.

Aviation Insurance Manual; Aero Insurance Underwriters, New York, 1941; 91 pages.

An explanation of what aviation insurance is, how much it costs, and the different types of insurance, as well as who and what it covers.

Rank and Badges in the Navy, Army, R.A.F. and Auxiliaries, edited by E. C. Talbot-Booth; George Philip & Son, Ltd., London, 1940; 36 pages, 7*d.*

A guide to recognition of the badges worn by various branches of the British armed and auxiliary forces. Colored illustrations show the braid, chevrons, and cloth and metal devices that distinguish the different ranks and organizations. Supplementary to these are abbreviations of naval and military terms, mottoes of some regiments and corps, and types of British naval craft and aircraft.

Library Accessions

Wings of the World; National Aeronautics Council, New York, 1940; 63 pages.

Photographs, specifications and performance data are given for 58 of the best known fighting, commercial and private airplanes produced in the United States, Great Britain, Germany, Italy, France, Soviet Russia and Japan.

Bob Wakefield's Flight Log, by Blaine and Dupont Miller; Dodd, Mead & Company, New York, 1940; 240 pages.

Adventures of a Navy flyer from Alaska to the South Pacific are narrated in accordance with current naval procedure by an officer of the Navy, for older boys.

Aviation, by Burr Leyson; Boy Scouts of America, New York, 1940; 66 pages.

One of a series of pamphlets, this gives elementary information on various phases of aeronautics and tells Boy Scout readers how to get added information from books on the subject and elsewhere.

Flight Surgeon, by Cameron Rogers and Herman E. Halland; Duell, Sloan and Pearce, New York, 1940; 295 pages.

This novel of love and adventure has a background of scientific discovery, of dangers undergone to safeguard the lives of pilots and the ordeal of a war problem realistically carried out.

Skycraft (New Edition), by Augustus Post; Oxford University Press, New York, 1933; 294 pages.

Flying, by James E. Fechet; The Williams & Wilkins Company, Baltimore, 1933; 138 pages.

The former chief of the Army Air Corps tells the story of the airman and answers many of the countless questions about airplanes and flying.

Instructions in Oxyacetylene Welding and Cutting Processes and **Arc Welding Instruction Course;** Air Reduction Company, New York, 1940; three books of 89 pages, 94 pages and 101 pages at $1.00 each and one of 31 pages at $0.65.

This course discusses the theory and practice of electric arc welding and oxyacetylene welding and cutting, with work sheets and diagrams.

Theory of Flight (Heavier Than Air); U.S. Government Printing Office, 1937; 43 pages.

A basic text on the theory, physics and dynamics of flight, designed to be a "first reader" on aeronautics for enlisted men.

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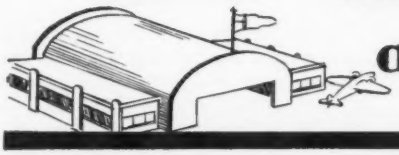
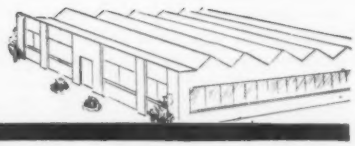




Aircraft Transparent Plastics

Chemists Call It Poly-Methylmethacrylate. A study of the various types of plastics, Lucite, Plexiglas, Vimal and others used in the construction of modern military aircraft. The places where each is used to best advantage, the process for molding and installing the transparencies are given along with directions for maintaining the plastics. *North American Skyline*, January.

Aircraft Relays

Specification sheets on the types 17 and 18 aircraft relays have been issued by the Automatic Electric Company of Chicago. The physical characteristics of the relays, their application, advantages and specifications are outlined briefly, and their availability in stock assemblies is presented.

Stainless Steel Data Sheet

A data sheet on *Resistal* stainless steel, giving in tabular form the information necessary in specifying or using leading stainless steel grades. The table lists the trade name and type number of the commonly used grades of the metal, gives its chemical analysis, structure, density, modulus of elasticity and other physical, electrical and mechanical properties, and heat resistance and tabulates the results that may be expected of the alloy in the conventional types of handling. *Crucible Steel Company of America.*

Bonding the Morrow Trainer

A study of the application of *Tego* phenolic resin bonding to the construction of the Morrow *Victory* two-place low-wing trainer. The manner in which the plywood skin is applied to the wood framework for the formation of an aerodynamically efficient surface, free from all rivets, nails, etc., is described. *The Resinous Reporter*, February.

Electrical Gages

Describing various types of electrical gages, such as strain and pressure gages, tensiometers, film thickness, eccentricity, profile and electrolimit gages, this booklet indicates their new application in defense industries. Specific uses in aircraft, engine, propeller and accessory manufacture are given. *General Electric*, Schenectady.

Improved Circuit Breaker

Improvements on the existent class 9300 aircraft circuit-breaker and toggle switch are described in a leaflet issued by the Square D Company. Without increasing the size of the enclosure, a red signal button system has been incorporated. If the circuit is opened because of an overload, the red button appears on the face plate. It lowers automatically on resetting. *Square D Company*, Regular Division.

Pyrometer Maintenance

Priorities and Pyrometers. The first of a series of wartime bulletins on the effect of material scarcity on the use and maintenance of temperature control instruments, this issue explains some of the application short cuts which, if applied, will increase the efficiency of the instrument and effectively lengthen its service life. It also offers some suggestions for substitution of certain critical materials by means of a comparative table of properties between the original and substitute material. *Wheelco Instruments Co.*, Chicago.

Strain Gage Bulletin

An engineering booklet on the electrical strain gage, this work explains its operating theory and the manner in which it may be used to measure static and dynamic strains. The general field of application of the instrument is indicated and the features which make the gage applicable to rapid use are presented. This is followed by a mechanical description of the instrument, and examples of practical application of the gage to specific strain-measuring tasks. *General Electric*, Schenectady.

Non-Sparking Tools

Protection Against Fire and Explosion. A booklet, describing a line of non-sparking safety tools made of beryllium-copper. These are designed to be used in the presence of explosives, combustible fumes, gases, dust, etc. It is pointed out that, while these specialized tools do not have the hardness of alloy steel, they should render comparable performance with reasonable care. *Ampco Metal, Inc.*, Milwaukee.

Hints for Magnesium Handling

Machining Magnesium Alloys. A general discussion of the operations, methods and problems involved in the machining of magnesium alloys. This article describes the mechanical characteristics of magnesium alloys, offers hints on machining procedure and lists precautions on the handling of tools while working on the alloy, keeping in mind the combustibility of the metal under certain conditions. The procedure in handling magnesium fires is also given. *The Houghton Line*, January.

Automatic Temperature Control

Automatic Temperature Control for the Defense Program. Stressing the importance of automatic temperature controls in aircraft, this leaflet explains the principles and traces the development of thermostatic bimetals. Graphic drawings detail specific applications in the production of automatic control. Complimentary copies are offered to engineers developing automatic temperature control devices for defense equipment. *W. M. Chace Co.*

Decarburization Study

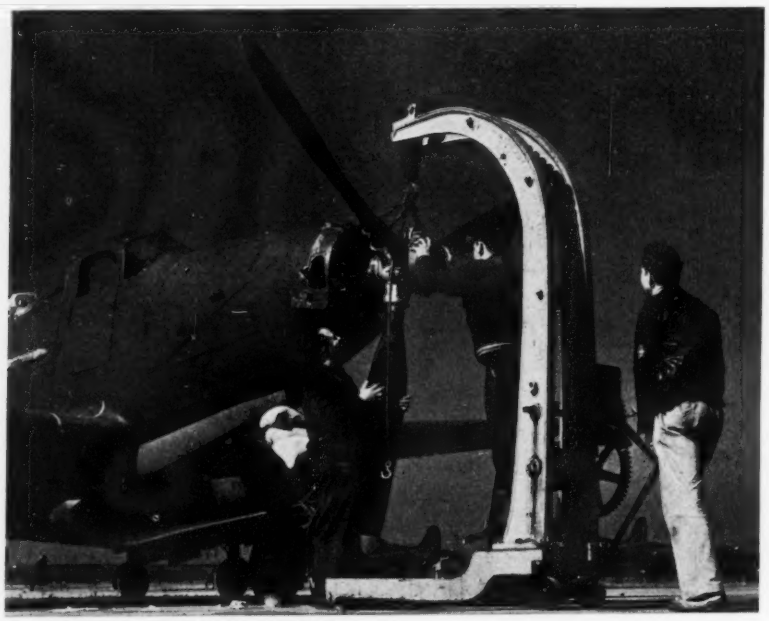
An addition to the loose leaf data book on Summerill Tubing, this chapter treats of the effect of decarburization as applied to quenched and tempered steel tubing, particularly S.A.E. X4130 Aircraft Steel. The article explains the nature of decarburization and indicates its allowable limits in the method of testing for it. Surface defects due to decarburization are indicated and methods for inspection of these defects for eccentricities and other faults are outlined. *Summerill Aircraft Tubing Data*, February.

Hydraulic Valve Lifters

Zero-Lash Hydraulic Lifters. Another in a series of articles on valve engineering, this installment discusses the zero-lash hydraulic valve lifter. The theory, operation and advantages of the hydraulic system in motor cars and aircraft engines are outlined and compared with the mechanical system as to operating efficiency, quietness and freedom from operational disorders. *Wil-Rich Forum*, January.

Supercharger Explained

Uplifters. A simplified study of the theory and operation of the supercharger, indicating the manner in which it provides the power plant with air of lower-level density at high altitudes and additional air for increased power output at normal operational levels. The article also outlines briefly the history of superchargers in Wright engines. *Trade Winds*, February.



Installing the Curtiss electric propeller on the Bell Airacobra.

Airship Brochure

Airships for National Defense and Commerce. A revision, in the light of current events, of a standard brochure on lighter-than-air craft, issued by Goodyear in 1939. It is a non-technical presentation of the varied potentialities of airships in civil and military aeronautics. It points out the use of non-rigid airships for coastal and harbor patrols, and also presents a plan whereby 12 rigid airships of about 6,500,000 cu.ft. capacity equipped with scouting airplanes and based at Los Angeles, Hawaii, Lakehurst, Puerto Rico and in the Panama Canal Zone could guard the United States against surprise attack.

Some details of a plan for the application of a rigid airship as an aircraft carrier are also explained, and the performance of this type as a long range transport is noted. The brochure also contains a survey on the production facilities for airships in the United States. *The Goodyear Tire & Rubber Company*, Akron.

One-Man Rivet

New Rivet Needs No "Dolly." A brief, diagrammed account of a rivet that can be stamped out of strip stock in an automatic eyelet machine at the rate of 110 per minute. Introduced by the Canadian Car and Foundry Company, this rivet can be applied by one man and is used primarily for "blind" sections of airplane frames, wings, and fuselage where riveters find it difficult to work with a holding "dolly" or bar. Its embodiment in actual combat planes has served to emphasize another feature of the tubular rivet form of construction in military craft. *Nickelsworth*, first quarter 1942. *The International Nickel Company, Inc.*

Flight Analyzer

Friez No. 640 Flight Analyzers. A data sheet on an instrument which records the altitude during flight in terms of barometric pressure. A picture of the analyzer as well as a sample chart supplement the description, specifications, and suggestions for installation. *Julien P. Friez & Sons.*

Fastener Catalogue

Fastening Devices. Catalogue No. 42 is a data book giving technical information on fasteners manufactured by Shakeproof, Inc., of Chicago, Ill. Its 140 pages contain detailed explanations of many different fastening products such as lock washers, thread-cutting screws, *Sems* fastener units, spring washers, locking and plain terminals, locking screws, and precision stampings. In addition to engineering data on types, sizes, and dimensions, application suggestions for saving time and improving fastening performance are given. A separate section is devoted to government specifications and approvals.

Design engineers, production men, and purchasing agents will find this catalogue a helpful guide to assembly operations. Copies are available to executives of metal working companies if requests are directed on company stationery. *Shakeproof, Inc.*

Electric Aircraft Motors

A four-page supplement to the General Electric standard catalogue is devoted exculsively to electric motors designed for aircraft service. Types, applications, and ratings are given for various fractional-horsepower frame sizes specifically adaptable to aviation needs. Among the standard models described are those suitable for the operation of cowl flaps, oil coolers, antenna reels, fuel pumps, and bomb hoists. *General Electric.*

Machine Tools Explained

Machine Tools. To answer the many questions being asked by the public on machine tools, the National Machine Tool Builders Association has issued a booklet on the function and use of machine tools, and their relation to the problem of national defense. After explaining simply what machine tools are and how they differ from the hand tools which are familiar to most laymen, the brochure presents a short history of machine tools and the contribution made by Eli Whitney to the technique of interchangeable manufacture.

The remainder of the booklet is devoted to explaining the basic machining processes, turning, boring, planing, milling, grinding, and their variations and combinations and how they are applied in modern high speed production. Many of the applications are indicated in airplane, airplane engine and accessory manufacture. *National Machine Tool Builders Association.*

From the Industry

Civil Aeronautics Administration

A total of 106,800 courses have been given in the Civil Aeronautics Administration pilot training program since 1939, at an average cost per course of $544, according to reports of Charles I. Stanton, Acting Administrator.

This sum includes all expenses of the several types of courses which have been given. These courses have produced flyers rated from private pilots to commercial pilots qualified as flight instructors and even pilots qualified for trans-ocean ferrying in a post graduate course. To produce a pilot worthy of a private license, the C.A.A. pays out $365. To produce a ferry pilot, the outlay is about $5,014.

Much of the C.A.A. money has been "invested" in training instructors, taking boys who had never flown before and giving them elementary, secondary, cross country and instructor courses, to meet the need of military and civil aviation for instructors. These trainees have immediately returned "dividends" on the government's investment in them by turning out other pilots. To make an instructor in this manner, the C.A.A. spent about $2,976. Several thousand of the 106,800 courses given were refresher courses, designed to make instructors of pilots who had had previous experience. For this course the C.A.A. paid $250.

All the courses were purchased by the C.A.A. under contracts with private firms and individuals who did the flying instruction, and colleges and non-college centers giving ground instruction. The C.A.A. merely supervised, set standards and regulated. The total of $66,000,000 appropriated by Congress for training civilian pilots includes the cost of administration.

Colonial Broach Company

Bringing tool-room precision to the production manufacture of an unusual part is now being accomplished in making the rotors used in the smallest series hydraulic pumps produced by Vickers, Inc., Detroit. From very limited quantities, production has been stepped up to a point where tooling must be adequate to handle 6,000 per month.

Extreme accuracy is necessary in maintaining the dimensions of the rotors, since the efficiency of the pump depends upon the fit of the rotor in the casing and also upon the ability of the vanes to move freely in and out of the rotor slots without by-passing measurable quantities of hydraulic fluid. The vanes are held radially against the casing by oil pressure, the oil being admitted to the backs of the vanes through holes in the casing. Space for the admission of the oil to the vanes is provided by holes at the base of each slot. These pumps have wide application for operating hydraulic mechanisms in many machine tools such as lathes, drills, planers, grinders, presses, broaching machines, etc., required for war production work.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assured by the Aeronautical Review.

Of particular interest is the method now used to produce the slots in the periphery of the rotor. When originally made in small quantities, the slots, which are only 0.0780 to 0.0785 in. in width, 0.6145 in. long, and $^{17}/_{32}$ in. deep, were milled one at a time. At the base of each slot a small hole for the admission of oil to the back of each vane was drilled prior to milling. Difficulty was experienced in maintaining the alignment of these holes so that the milling cutter would cut squarely into each hole on both sides of the rotor.

Broaching was then considered as a more accurate means of cutting the slots, and forming the holes. The needed tooling was developed by Colonial Broach Company, Detroit. When increased production was demanded, facilities were thus available to handle an increased quantity.

The slots are broached in two passes, two slots at a time. Spacing of the two broaches is approximately one-third the circumference of the part. Colonial Universal horizontal broaching machines equipped with broach guide bars are used for this operation. The first pass cuts about one-half of the total depth of the slots. The second pass completes the depth and forms the holes at the bottom of the slots. In the slotting operation the hub is used to locate the position and alignment of the slots, so that they are spaced between the markings mentioned later. No further operations are necessary on the slots, after the rotors are hardened and ground. Using this method has virtually eliminated scrap. Less than a dozen out of 12,000 parts were scrapped during a recent run.

Another problem was to maintain the concentricity and especially freedom from "wobble" of the rotor within narrow limits, due to close fit between the faces of the rotor and casing. To overcome this difficulty, the splined portion of the hub is used as the basic locating point for all operations subsequent to splining the hub.

Operation No. 1 is conventional and consists of roughing the rotor blank from cold rolled bar stock. In the second operation the spline is broached in the center portion of the hub, using a Colonial horizontal broaching machine. Next all diameters of the rotor are finish turned on a splined mandrel, including the chamfers at the ends of the hole which form centers for later grinding. This "transfers" the locating points from the spline to the chamfered ends and is considered the key to the accuracy with which the spline aligns with the rotor and hub ends after finish grinding.

A special machine was developed by New Method Steel Stamps, Inc., Detroit, to mark the periphery of the rotor with the direction of rotation, name and part number, Operation No. 4. This operation is performed prior to the slotting, so that it cannot possibly deflect the slots from true position. In this machine the splined portion of the hole is used to locate the position of the markings so that when broached the markings will be precisely located between the slots. The marking machine is operated by a control valve under the operator's foot. Each stroke of the piston rod reciprocates a shaft on which the part is mounted. This shaft is geared to another shaft on which the roll marker is mounted. Thus the marks are precisely located on each rotor. The machine is extremely rapid in operation

Our Rendezvous with DESTINY

WITH the world the battleground for freedom, we face the gravest crisis in our history. Because this is *total war*, certainty of our victory is possible only as we become soldiers all. There's a soldier's job to do on the farm, in the mine, at the factory, yes, and in the home. America united is America invincible.

The order of the day for soldiers of Democracy in and out of uniform is, "Fight with *everything* you have for *everything* you hold dear." Only in that great day of final victory will we have kept our rendezvous with destiny and be able to "look forward and move forward to a future worthy of men with peace in our hearts."

We of the vast army of aircraft production soldiers again pledge our total effort to build in overwhelming volume the wings with which fighting America will triumph in justice. Whoever you are, wherever you are — in your own way, you can do no less.

Donald W. Douglas

PRESIDENT, DOUGLAS AIRCRAFT CO.

and is capable of marking up to 500 rotors per hour if required, two rotors being marked on each full cycle of the machine. The fifth operation is broaching the slots as previously noted.

After carburizing and hardening the rotors (Operation No. 6), the chamfered ends of the hole are lapped in a drill press (Operation No. 7) to form centers for the subsequent grinding operation (No. 8), which consists of finish grinding the O.D. and faces of the rotor and of the two ends of the hub. No commercially measurable "wobble" of the faces of the rotor relative to the hubs is permitted after grinding. Diameter of the rotor is approximately $2^{17}/_{32}$ in.

The Dumore Company

The Dumore Company of Racine, Wisconsin, announced the production of the series E2Y1PC electric aircraft motor, rated at $^1/_6$ hp. at 1500 r.p.m. The motor incorporates a magnetic clutch and brake in its design, and is being supplied to the Folmer Graflex Company for motive power in aerial cameras.

The clutch disengages the armature from the gears at the instant the circuit is opened and the brake brings the output shaft to a stop in a fraction of a second.

An entire series of twelve modifications of the above motor is available. It can be supplied with the basic motor only; basic motor with clutch; basic motor with single or double gear reductions; and basic motor with single or double gear reductions and magnetic clutch.

These motors are now used for such applications as cowl and wing flap controls, oil cooler controls and aerial camera controls.

The E2Y1PC has an over-all length of 8 in. and weighs 4 lbs. The motor is also available with ratings of $^1/_8$ hp. at 1500 r.p.m., $^1/_{10}$ at 200 r.p.m. or $^1/_8$ hp. at 200 r.p.m.

General Electric Company

Tubular parts for the Lockheed interceptor aircraft now being turned out for use both by this country and Great Britain are produced in record time at the Menasco Manufacturing Company. Since these vital parts must be both elastic and tough to withstand the strain of interceptor movements, careful heat-treating is essential.

To accomplish this job in step with today's high-geared production, Menasco has installed four General Electric cylindrical electric furnaces for hardening and drawing, and a water-cooled oil quench. Two G-E atmosphere gas converters maintain an inert atmosphere in the furnaces and assure that the analysis of gas in the furnaces is constant regardless of changes in the rate of flow.

Heretofore, one of the greatest difficulties in hardening and drawing tubular parts has been excessive cooling encountered in transferring the parts from the furnace to the quench tank. This difficulty has been overcome at Menasco by installing two quenching hoods on the G-E hardening furnaces to protect the parts as they are transferred.

This transfer of parts is accomplished quite simply. After the charge is brought up to the proper temperature in the hardening furnace, a high-speed hoist, equipped with a transfer hood, is brought over the furnace and the charge quickly pulled into the transfer hood. The hood is then positioned over the oil quench tank and the charge quickly dropped into the oil. This transfer hood minimizes cooling, warpage and scaling of the thin-wall tubular parts during transfer from the furnace to the oil quench tank.

Gisholt Machine Company

A newly developed circular forming tool holder for use on turret lathes has recently been announced by Gisholt Machine Company.

The device has been designed for use on either the front or the rear of the cross slide, since cutters may be mounted on either side of the holder. Provision has been made for adjusting and locking the cutter so the cutting edge can always be properly positioned after grinding. A further feature is the pivot mounting of the holder, the pivot having an adjustment for correcting slight inaccuracies of the cutter.

Kollsman Instrument Division Square D Company

The increasing speed of military aircraft is reflected in a new sensitive air speed indicator of 700 m.p.h. range developed by Kollsman for the U.S. Army.

In this new type indicator, the speed in hundreds of miles per hour is indicated by the rotating subdial. The pointer makes seven complete revolutions of the dial for the full range or one complete revolution for every hundred m.p.h. The air speed can be read to one m.p.h. at any speed.

This Kollsman sensitive air speed indicator is also available in 500 and 600 m.p.h. ranges.

Mead Specialties Company

Mead Specialties Company announced two additions to the line of air clamps recently placed on the market. The additions, the H4 Air Clamp and a new Air Clamp foot control, were developed for aircraft manufacturers. These items are now available to all defense contractors.

The H4 clamp is a variation of the drill-press model, and is adaptable to many forms of milling operations. It also has wide applications in assembly jigs. It is possible to operate groups of Air Clamps in assembly jigs by one master valve. Like the drill-press Air Clamp, the H4 produces a hold-down pressure of four times the line pressure.

The other item announced is a new type of foot control for the clamps. With this control, work-cycles may be sped up as the operator's hands are released for a more rapid feed of new work.

Feature of the H4 Air Clamp is the ease with which it can be set for various operations. Jigs can be reduced to the simplest forms, while built-in clamps and hold-downs can be eliminated, by applying these clamps as the flexible pressure permits allowances for variations in thickness of the work, a frequent cause of trouble with castings.

Metal Textile Corporation

To be most effective, breather units should be relatively open, permitting the air to flow freely through the mesh while rejecting the oil. This has now been made possible by an improvement in the construction of wire mesh. This new type of mesh, introduced by Metal Textile Corporation of Orange, N. J., is knitted instead of woven. It consists of a series of loops which hinge on each other, so that relatively large openings in proportion to the diameter of the wire may be used.

A breather unit can thus be arranged so that the air flows through the mesh, while the oil, instead of being retained on the wires and clogging them, drops back into the oil chamber. These breather units have an unusually high efficiency in removing dust and dirt from air passing through high speed motors. They have three variations in the openings of the mesh—for cylindrical breathers, for solid plugs, for rectangular and square-shaped breathers.

The hinge action of knit wire mesh relieves the tension on the wire itself, thus producing a mesh fabric that has high tensile strength in proportion to its weight. This mesh may be obtained in either flat or round wire; and unlike other types of mesh, it is easily wound and fashioned into shape after it is crimped. It can be made of any metal that is commonly drawn into wire, such as: platinum, silver, tungsten, tantalum, molybdenum, copper, non-ferrous alloys, nickel, monel metal, inconel, steel, aluminum and aluminum alloys.

Mid-Continent Airlines

L. H. Hagie and L. H. Mouden, of Mid-Continent Airlines, Inc., have recently developed a wind simulator attachment for the Company's Link

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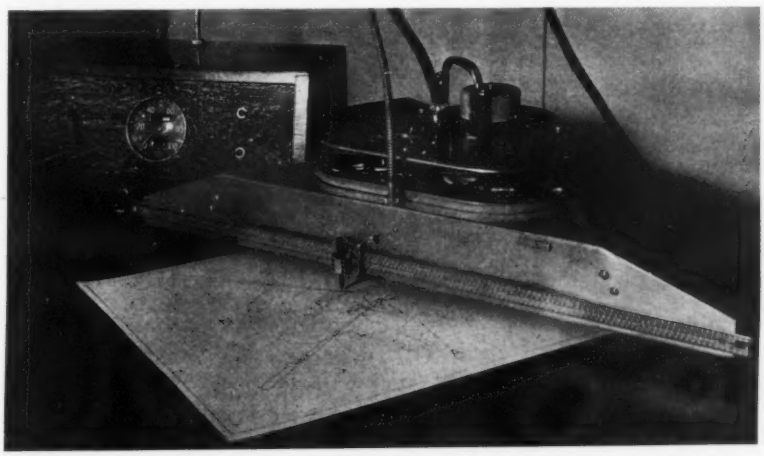
Trainer. This device employs the principle of a moving pen traveling at a definite rate to correspond to the "wind" desired. The simulator is remarkably accurate in reproducing all conditions of wind drift, for a wind from any fifteen degree angle, and can be adjusted to vary the wind velocity from ten to over one hundred miles per hour.

The Hagie-Mouden simulator comprises a cable-drawn pen carriage, mounted on a light track, and driven through a gear-reduction box by means of a flexible shaft. The track and pen-carriage unit mounts directly on the Link Trainer recording head, or "crab" as it is commonly called, by means of three screws, and requires no alteration of the Link in any way.



The Hagie-Mouden wind simulator, developed by two pilots of Mid-Continent Airlines to give the effect of varying winds to students in the Link Trainer.

The wind simulator driving unit consists of a reversible, variable-speed, motor-driven control unit connected to a "wind" velocity indicator. This is connected to the pen unit on the "crab" by means of a flexible shaft. The driving unit is encased to match the instrument panel mounted on the operator's desk.

The designers and builders believe that their wind simulator has several outstanding features to recommend it. It is extremely simple to install, and requires only the tightening of three screws and plugging of the drive unit into a convenient outlet to be put into operation. The comparative ease of manufacture and the minimum amounts of material and machining operations required to produce the simulator make it particularly valuable in fulfilling the need for this essential addition to all Link Trainers. It can sell for as little as $200 when produced on a commercial basis. Because of the simplicity of the wind simulator, it is felt that it is of particular value during the present war crisis. The device can be constructed from non-essential materials, and such a device is of great importance in the primary training of all pilots when they receive instruction on Link Trainers. The fact that it can be installed to any Link Trainer in five minutes time, makes it particularly adaptable to effective use.

The success of their wind simulator has encouraged Hagie and Mouden to develop other ideas and start construction of another attachment for the Link Trainer which will greatly increase the usefulness of the Trainer in giving instrument and radio flight training.

Hagie and Mouden are First Officers with Mid-Continent. Hagie, in addition, has served as Link Trainer and Instrument Flight Instructor with MCA, and has been in the employ of the Company for two years. Hagie first entered the aviation field in 1926, and has had a varied and experienced career in aviation. He has served as Link Trainer Instructor for United Air Lines, and has had several years training in the Army Air Corps. Mouden has served on the faculty of Iowa State College, and received his Master of Sciences' degree there. While at the College Mouden had considerable experience in technical research, and he has done a great deal of instrument making, both at Iowa State, and later with the Aero Tool Company in Burbank, California. He joined Mid-Continent in June of 1941.

Progressive Welder Company

A low cost installation for welding together ends of strips has recently been announced by Progressive Welder Company. It consists of two simple air-operated series-connected guns for spot welding, a notched bar to locate welds, and a control handle to move the gun along, the entire assembly being supported from an I-beam section above which is located the welding transformer.

To weld strips together the operator moves the gun to the first notch. This trips a switch, causing welds to be made. The gun is pulled along to the second notch, causing another pair of welds to be made, etc., for as many welds as needed for the specific strip width. A button is provided on the control handle to prevent closing of the welding circuit when the gun is returned to starting position.

Ryan Aeronautical Company

Tests were recently completed on a new seaplane model of its latest type primary military trainer developed by the Ryan Aeronautical Company. Designated ST3-S, the seaplane trainer differs from the Air Corps' latest Ryan PT-22 trainers only in the substitution of twin floats for the conventional landplane landing gear. The new ST3-S seaplane trainer is powered with a 160 hp. Kinner engine, and is the first radial powered Ryan trainer to be available as a seaplane.

Tinnerman Products, Inc.

Junction box covers may now be attached in less than one-fourth the usual time, without the use of bolts, rivets, nuts or tools of any kind.

The new and faster method is with a two piece Speed Clip that can be snapped by hand into holes in the sides of boxes or other enclosures. It is so constructed that it can be used universally on boxes ranging from 0.025 in. to 0.064 in. in thickness. Similar Speed Clips for thicker material are also available.

Both parts of the clip are made of high carbon spring steel. One part snaps into a hole in the side of a junction box, while the second part hinges on the first and has an integrally formed dimple on the end which snaps into a hole or mated dimple in the box cover.

With these new Speed Clips, covers are locked to boxes with a firm spring tension, but can be instantly removed or attached without the use of any tools. Junction boxes now in use can be adapted to these new fasteners by merely drilling and notching as required.

Turco Products, Inc.

A new compound for removing the zinc chromate primer from aircraft parts was introduced recently by Turco Products of Los Angeles. The new material is called *Turco Slip*, an alkaline-reacting, non-volatile, water soluble solvent. The new material is rapid in action, functioning on a physical rather than a chemical basis; therefore it does not attack the aluminum alloys, as it is inhibited against attack on aluminum and therefore may be used on that metal without hesitancy. It involves no fire hazard. It is nontoxic and although it

A WAR MESSAGE
to
ALL EMPLOYERS
★ From the United States Treasury Department ★

WINNING THIS WAR is going to take the mightiest effort America has ever made—in men, in materials, and in money! Every dollar, every dime that is not urgently needed for the civilian necessities of food, clothing, and shelter, must, if we are to secure final Victory, be put into the war effort.

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is recommended that workers wear rubber gloves when handling the material, this precaution is probably not essential.

Shapes to be stripped of primer should be immersed in the solution full strength. The prescribed immersion temperature for stripping aluminum parts is 140 to 145°F. Aluminum will be stripped after an immersion time of from three to five minutes. Pieces should be completely submerged during the stripping soak. Contact of dissimilar metals should be avoided if submersion time is extended to eliminate the possibility of electrolytic action. After immersion the primer detaches itself from aluminum and may be removed in sheets. The parts should be rinsed in clear water.

While this solvent was designed specifically for the removal of zinc chromate type primers, it is also excellent for the removal of most types of enamels, lacquers, paints and similar finishes. For this type of work it should be employed at a temperature of 160°F.

This new material is also being used for stripping prime coats on surfaces too large for submerging in a tank. This is accomplished by filling a bucket with *Turco Slip* from a hot tank and applying it to fuselage or wing sections with swabs.

United Air Lines

Use of a new and powerful radio range station at Ogden, Utah, to permit a straight, simplified approach to the Salt Lake City Airport along a unique "double track" of radio signals, the first installation of this type, was announced recently by United Air Lines as the latest development.

The Ogden radio beam, installed by the Civil Aeronautics Administration, is only 30 miles from the Salt Lake Airport, and planes now approach that airport on a double beam over considerably lower terrain than that over which the former course led.

Pilots of United Air Lines Mainliners approaching the Salt Lake flats from the east simply fly down the "on course" line of signals provided by the south leg of the Ogden range and the north leg of the Salt Lake range. This new block system of the air permits one pilot to keep tuned to the frequency of the Ogden range while the other pilot tunes to the frequency of the Salt Lake range. Thus, there is a "double track" of signals and a double check of the "on course" line of flight.

Seely V. Hall, vice-president in charge of western operations for United Air Lines, said the Ogden range has been approved for use by the Civil Aeronautics Administration and that planes are now being routed over the lower route to Ogden in approaching Salt Lake.

Western Felt Works

Saran, a new thermoplastic, the wide range and characteristics of which enable it to relieve some of the immediate production difficulties due to metal shortages, is being fabricated by Western Felt Works, Acadia Synthetic Products Division, under license by The Dow Chemical Company, producers of Saran. Principal characteristics of this new plastic are its toughness and its high resistance to moisture, brine, solvents, acids, and alkalies. Under fatigue tests, Saran tubing recently was flexed 2,500,000 times through a 15° arc, 1,750 times per minute, without failure.

Saran tubing is to be fabricated in a wide range of sizes and thicknesses, ranging from $^1/_8$-in. to $^3/_8$-in. outside diameter. Its characteristics enable it to replace metal tubing in many applications, except where extremely high temperatures and very high pressures are encountered. It can be joined by standard flare-type or compression fittings. Joined with standard tubing couplings, Saran tubing withstood a pressure of 1,500 lb. per sq. in. without rupture or leakage.

Westinghouse Electric & Manufacturing Company

A voltage regulator, no bigger than an ordinary box camera, is now helping supply current to radios and instruments of planes, according to Sherwin H. Wright, aviation industry engineer of the Westinghouse Electric & Manufacturing Company.

The improved regulator operates at temperatures ranging from 40°F. to below zero, and from sea level to more than 35,000 ft. in altitude.

Smallest and lightest instrument of its kind ever produced, the regulator has passed all laboratory tests successfully, has operated satisfactorily on test flights and is now in quantity production. It weighs less than 2 lbs. but handles three times more electric current than its predecessors. The smallest regulator for industrial use weighs 13 lbs. and is almost four times the size of its aircraft contemporary. Designed for quick mounting and easy repair, the new regulator is conveniently installed in the fuselage of airplanes.

A new aircraft reverse current cutout described also weighs less than 2 lbs. and performs the same function as an automobile cutout. It permits the flow of generator current to the storage batteries when the generator voltage is great enough to charge the batteries, but disconnects the two units when the voltage drops below the charging point. By thus breaking the circuit, the cutout avoids wasteful reverse current which would flow out of the battery and diminish the small store of power. Added advantages are greater accuracy, more current capacity and special construction to withstand shocks and vibration caused by the powerful main engines.

The Zadig Patents

An aural airplane detector easily carried and operated by one man has been developed for use by individual "spotters" of the Aircraft Warning Service. The device with all accessories, including a self-contained power supply, is housed in a case smaller than a gas mask container. Slung over the watcher's shoulder, it enables him to act as an independent mobile airplane pickup unit.

In action, the spotter puts on a headpiece consisting of earphones topped by a parabolic "concentrator" of sound waves, from which wires are plugged into an amplifying apparatus in the case. When a low-pitched sound in the earphones heralds the approach of a plane, the spotter turns his body until the sound is at its loudest. He is then facing the oncoming plane and is able to orient his binoculars swiftly and accurately on the aircraft to be identified.

The device has been tested by technicians of the U.S. Army Signal Corps and by members of the Aircraft Warning Service. It is claimed it can be used effectively by technically untrained spotters. Steps have been taken for production in the quantities needed by spotting units throughout the country.

The concentrator is of thermoplastic material molded to a parabolic curve and containing crossed perpendicular veins which sharpen the aural focus. A microphone of special characteristics is placed at the focal point. The headband which carries the earphones also supports the concentrator.

The amplifier and its batteries are contained in a shielded drawer which slides into a compartment at the bottom of the carrying case. In case of breakdown or needed service, this drawer is simply withdrawn and a new one inserted. The amplifier makes use of three tubes of the miniature type which are connected in an extremely high gain circuit. Filters eliminate noises other than those emanating from the approaching plane.

A volume control knob regulates the sound in the earphones to the watcher's comfort. This knob is easily accessible to the left hand when the case is hung from the shoulder by its strap.

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Airesearch Manufacturing Company
Edward G. Budd Manufacturing Company

CORD (SHOCK)

The B. F. Goodrich Company

COWLS

Airplane Division (Buffalo Plants), Curtiss-Wright Corporation
Edward G. Budd Manufacturing Company
Vega Airplane Company

DE-ICER EQUIPMENT

Eclipse Aviation Division, Bendix Aviation Corporation
The B. F. Goodrich Company
Pump Engineering Service Corporation

ENGINES

Allison Division, General Motors Corp.
Eclipse Aviation Division, Bendix Aviation Corporation
Guiberson Diesel Engine Company
Jacobs Aircraft Engine Company
Packard Motor Car Company
Pratt & Whitney Aircraft Division, United Aircraft Corporation
Ranger Aircraft Engines Division, Fairchild Engine and Airplane Corporation
Warner Aircraft Corporation
Wright Aeronautical Corporation

FABRICS

Wellington Sears Company

FASTENERS

Boots Aircraft Nut Corporation
Eaton Manufacturing Company
Simmonds Aerocessories, Inc.
Thompson Products, Inc.
Tinnerman Products, Inc.
United Carr Fastener Corporation

FITTINGS (STRUCTURAL)

Edward G. Budd Manufacturing Company
Fleetwings, Inc.
Vega Airplane Company

FINANCIAL SERVICES

The Chase National Bank of the City of New York
The National City Bank of New York

FLOATS & SKIS

Edo Aircraft Corporation
Goodyear Tire & Rubber Company, Inc.

FLOORING

Simmonds Aerocessories, Inc.

FORGINGS

Edward G. Budd Manufacturing Company
Thompson Products, Inc.
Wyman-Gordon Company

FUEL & HYDRAULIC SYSTEMS

Aircraft Accessories Corporation
American Bosch Corporation
Bendix Aviation Ltd.
Bendix Products Division, Bendix Aviation Corporation
Chandler-Evans Corporation
Eclipse Aviation Division, Bendix Aviation Corporation
Fleetwings, Inc.
Pump Engineering Service Corporation
Simmonds Aerocessories, Inc.

FUELS & OILS

The Pure Oil Company
Shell Oil Company
Socony-Vacuum Oil Company
Standard Oil Company of California
Standard Oil Company (Indiana)
Standard Oil Company of New Jersey
The Texas Company

FUSES

Littelfuse Incorporated

GEAR BOXES (ACCESSORY DRIVE)

Eclipse Aviation Division, Bendix Aviation Corporation
Pump Engineering Service Corporation

GENERATORS

Eclipse Aviation Division, Bendix Aviation Corporation
Westinghouse Electric & Manufacturing Company

HOSE (RUBBER)

Aeroquip Corp.
Firestone Aviation Products Company
The B. F. Goodrich Company
Goodyear Tire and Rubber Company, Inc.

HOSE CLAMPS

Breeze Corporations
Wittek Manufacturing Company

INSTRUCTION

Boeing School of Aeronautics
Casey Jones School of Aeronautics

INSTRUMENTS (AIRCRAFT)

Breeze Corporations
Fairchild Aviation Corporation
W. & L. E. Gurley
Kollsman Instrument Division, Square D Company
Pioneer Instrument Division, Bendix Aviation Corporation
Simmonds Aerocessories, Inc.
Sperry Gyroscope Company
Westinghouse Electric and Manufacturing Company
Weston Electrical Instrument Company

INSTRUMENTS (ENGINE)

Breeze Corporations
Eclipse Aviation Division, Bendix Aviation Corporation
Kollsman Instrument Division, Square D Company
Pioneer Instrument Division, Bendix Aviation Corporation
Simmonds Aerocessories, Inc.
Weston Electrical Instrument Company

INSTRUMENTS (METEOROLOGICAL)

Julien P. Friez & Sons Division, Bendix Aviation Corporation
W. & L. E. Gurley
Kollsman Instrument Division, Square D Company
Simmonds Aerocessories, Inc.

INSURANCE

Associated Aviation Underwriters
Aero Insurance Underwriters
United States Aviation Underwriters

LANDING GEAR

Bendix Products Division, Bendix Aviation Corporation
Cleveland Pneumatic Tool Company
Thompson Products, Inc.

LIGHTS & ACCESSORIES (AIRPORT, AIRWAY)

American Bosch Corporation
Westinghouse Electric and Manufacturing Company

MAGNETOS

American Bosch Corporation
Scintilla Magneto Company

MANIFOLDS (EXHAUST)

Airplane Division (Buffalo Plants), Curtiss-Wright Corporation
Edward G. Budd Manufacturing Company
Vega Airplane Company

METALS (STRUCTURAL)

Aluminum Company of America
American Rolling Mill Company
Climax-Molybdenum Company
Summerill Tubing Company
United Carr Fastener Corporation

MOLYBDENUM ALLOY

Climax Molybdenum Company

NAVIGATIONAL EQUIPMENT

Fairchild Aviation Corporation
W. & L. E. Gurley
Pan American Navigation Service
Pioneer Instrument Division, Bendix Aviation Corporation
Simmonds Aerocessories, Inc.

NICKEL & NICKEL ALLOYS

International Nickel Company

OXYGEN EQUIPMENT

Pioneer Instrument Division, Bendix Aviation Corporation

PISTON RINGS

Thompson Products, Inc.

PLASTICS

Bakelite Corporation
Duramold Aircraft Corporation
Firestone Aviation Products Company
United Carr Fastener Corporation
Westinghouse Electric and Manufacturing Company

PLYWOOD

Duramold Aircraft Corporation

PROPELLERS

Eaton Manufacturing Company
Hamilton Standard Propellers Division, United Aircraft Corporation
Propeller Division, Curtiss-Wright Corporation

PROPELLER PARTS

Eaton Manufacturing Company
Eclipse Aviation Division, Bendix Aviation Corporation
Hamilton Standard Propellers Division, United Aircraft Corporation
Lycoming Division, Aviation Manufacturing Corporation
Propeller Division, Curtiss-Wright Corporation
Thompson Products, Inc.

PROPELLER PRODUCTION MACHINERY

Engineering and Research Corporation

PUMPS (AIR, FUEL, OIL, VACUUM, HYDRAULIC)

American Bosch Corporation
Eclipse Aviation Division, Bendix Aviation Corporation
Chandler-Evans Corporation
Dowty Equipment Corporation
Fleetwings, Inc.
Pump Engineering Service Corporation
Thompson Products, Inc.

RADIOS (AIRCRAFT & AIRPORT)

Aircraft Radio Corporation
Bendix Aviation Ltd.
Bendix Radio Corporation
Fairchild Aviation Corporation
Sperry Gyroscope Company
Washington Institute of Technology
Westinghouse Electric and Manufacturing Company

REMOTE CONTROL & RECORDING DEVICES

Breeze Corporations
Eclipse Aviation Division, Bendix Aviation Corporation
Fairchild Aviation Corporation
Pioneer Instrument Division, Bendix Aviation Corporation
Simmonds Aerocessories, Inc.
Westinghouse Electric and Manufacturing Company

RIVETS

Aluminum Company of America
The B. F. Goodrich Company

RUBBER PRODUCTS

Firestone Aviation Products Company
General Tire & Rubber Company
The B. F. Goodrich Company
Goodyear Tire & Rubber Company

SCREWS, NUTS & BOLTS

Boots Aircraft Nut Corporation
Continental Screw Company
Eaton Manufacturing Company
National Screw and Manufacturing Company
Thompson Products, Inc.
Tinnerman Products, Inc.
United Carr Fastener Corporation

SEATS (PILOT)

Bendix Products Division, Bendix Aviation Corporation
Edward G. Budd Manufacturing Company
Firestone Aviation Products Company
The B. F. Goodrich Company

SELF SEALING COUPLINGS

Aeroquip Corp.

SPARK PLUGS

The BG Corporation
Scintilla Magneto Company
Simmonds Aerocessories, Inc.

STAINLESS STEEL

American Rolling Mill Company
Breeze Corporations
Edward G. Budd Manufacturing Company
Summerill Tubing Company

STAMPINGS (METAL)

Edward G. Budd Manufacturing Company
Eaton Manufacturing Company
Firestone Aviation Products Company
Fleetwings, Inc.

STANDARD PRECISION WEIGHTS & MEASURES

W. & L. E. Gurley

STARTERS

Breeze Corporations
Eclipse Aviation Division, Bendix Aviation Corporation

STRAINERS

Michigan Wire Cloth Company

STRUTS & SHOCK CORD

Bendix Products Division, Bendix Aviation Corporation
Cleveland Pneumatic Tool Company
Dowty Equipment Corporation
Firestone Aviation Products Company
Warner Aircraft Corporation

SURVEYS (AERIAL)

Fairchild Aerial Surveys, Inc.

SURFACES (WING & CONTROL)

Edward G. Budd Manufacturing Company
Firestone Aviation Products Company
Fleetwings, Inc.
Goodyear Aircraft Corporation

SWITCHES

Breeze Corporations
Eclipse Aviation Division, Bendix Aviation Corporation
Westinghouse Electric and Manufacturing Company

TACHOMETERS

Kollsman Instrument Division, Square D Company
Pioneer Instrument Division, Bendix Aviation Corporation
Weston Electrical Instrument Company

TIE RODS

Breeze Corporations
Edward G. Budd Manufacturing Company
Thompson Products, Inc.

TIRES & TUBES

Firestone Aviation Products Company
General Tire & Rubber Company
The B. F. Goodrich Company
Goodyear Tire & Rubber Company

TOOLS

Cleveland Pneumatic Tool Company

TUBING (FLEXIBLE)

Aeroquip Corporation
Breeze Corporations
Eclipse Aviation Division, Bendix Aviation Corporation

TUBING (RIGID NON-FERROUS)

Aluminum Company of America

TUBING (RUBBER)

Aeroquip Corporation
Firestone Aviation Products Company
General Tire & Rubber Company
The B. F. Goodrich Company

TUBING (STAINLESS STEEL)

Summerill Tubing Company

TUBING (STREAMLINE)

Summerill Tubing Company

VACUUM SYSTEMS

Simmonds Aerocessories, Inc.

VALVES & ACCESSORIES

Aeroquip Corporation
Cleveland Pneumatic Tool Company
Eaton Manufacturing Company
Eclipse Aviation Division, Bendix Aviation Corporation
Fleetwings, Inc.
Pump Engineering Service Corporation
Simmonds Aerocessories, Inc.
Thompson Products, Inc.
Westinghouse Electric and Manufacturing Company

WHEELS & BRAKES

Bendix Products Division, Bendix Aviation Corporation
Firestone Aviation Products Company
General Tire & Rubber Company
The B. F. Goodrich Company
Goodyear Tire & Rubber Company
Simmonds Aerocessories, Inc.
Warner Aircraft Corporation

WIRE ROPE & CABLE

John A. Roebling's Sons Company

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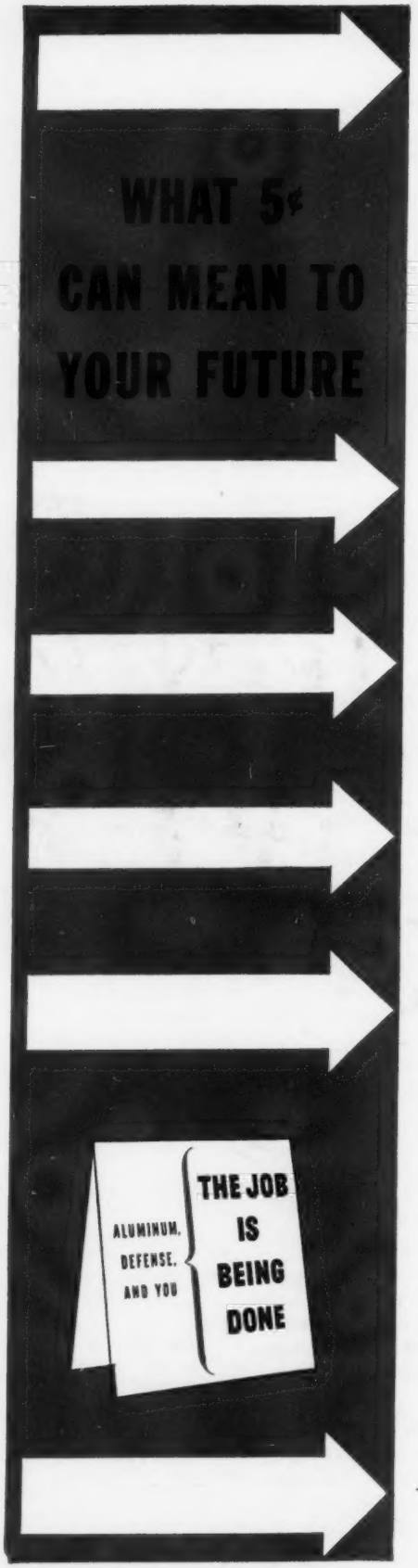


★

HOW MUCH ALUMINUM we are making now is a censored secret. We are determined it shall be sufficient to the need.

HOW MUCH WILL BE AVAILABLE, after the war, is idle talk now.

THE PRICE OF ALUMINUM is the thing that's important. It is important to the war, because our reduction of the price of ingot from 20c to 15c is saving the Government many millions of dollars a year.

THAT FIVE CENTS doesn't make aluminum one whit more useful for war purposes—only more patriotic.

BUT IT DOES MAKE aluminum terribly important to the peace. Real peace means jobs for all. Jobs-for-all come into being only when people *want to* buy and *can* buy: Which means new things, better things, at a price.

IMAGINEERING is the word we have coined to describe the thinking which is used to get those new things ready. Imagineering is letting your imagination soar and then engineering it down to earth. Imagineering needs tools as well as brains.

THAT FIVE CENTS we've lopped off the price of aluminum, so far, has more potentialities of creating new things and better things, at a price, than any single thing we know of.

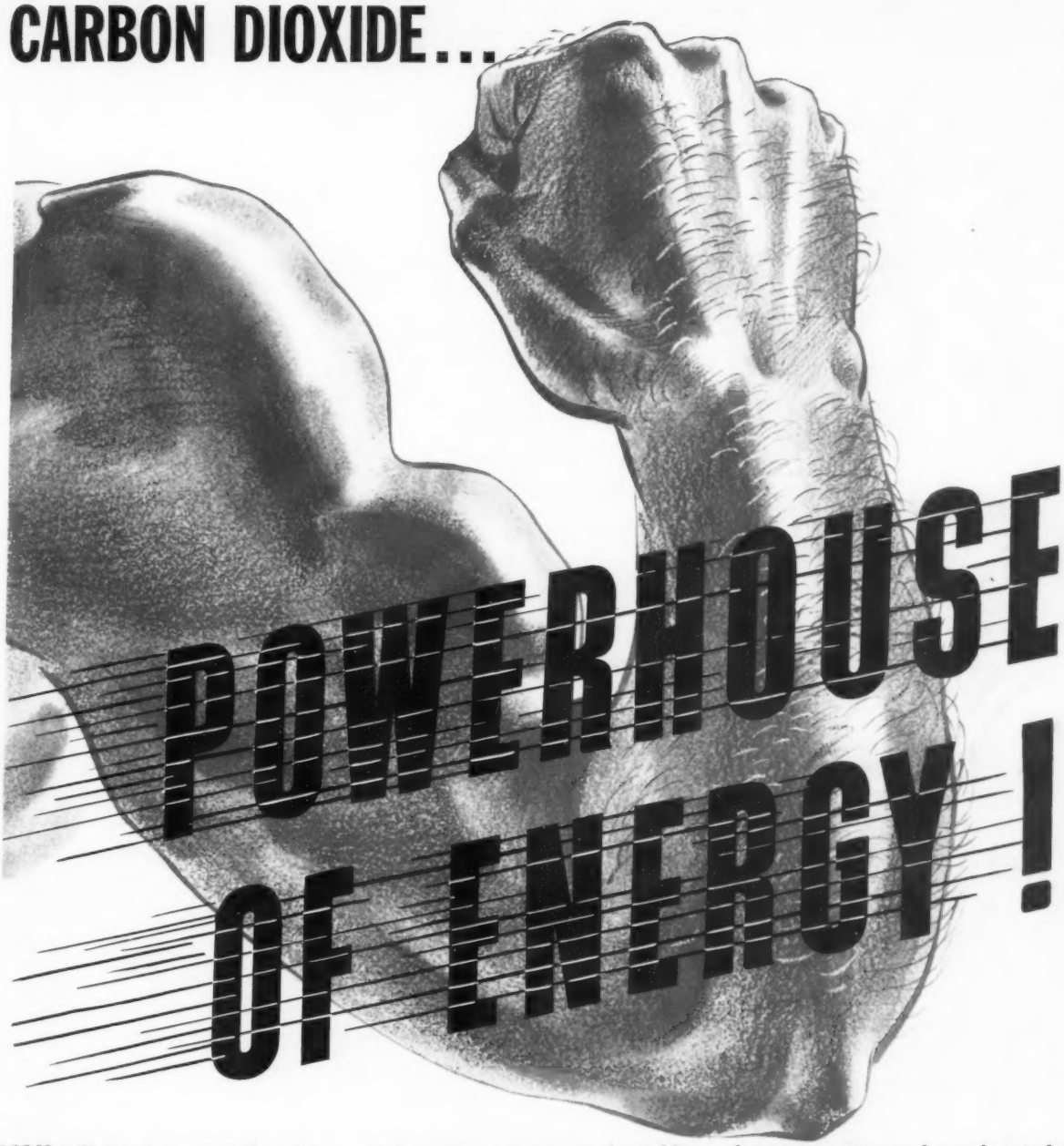
THAT'S WHERE YOU COME IN. You are the man *who*. You are the man America is counting on to make the jobs Americans are going to need. You are the man who is going to do the *Imagineering*, in your specialty, that is going to win the place for yourself, your employees, your associates.

YOU ARE GOING TO DO IT, and we hope you are going to let Alcoa help. We can, and we want to.

Aluminum Company of America, 2142 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

CARBON DIOXIDE...



YOU will want to remember this about carbon dioxide. It is the *most compressible* of the industrially available gases.

In the LUX Fire Extinguishing System and in other applications of the gas we store carbon dioxide at 850 pounds pressure per square inch. Under these conditions carbon dioxide is a liquid. When released into the atmosphere it becomes a gas . . . and *expands 450 times its former stored volume!*

Harness this terrific expansion and you have a source of quickly available power, produced by the turn of a valve. Here are some specific figures: In storage, under 850 lbs. pressure at 70°F., there are *30,000 foot pounds in a single pound of carbon dioxide!* By comparison with usual gases, as nitrogen, carbon dioxide gives you 3 times the available energy.

Engineers of Walter Kidde & Company have designed valves which release this energy in an instantaneous burst, or which apply the power over a prolonged period, a bit at a time.

If you have a problem involving power actuation, consider carbon dioxide. Its high factor of available energy gives this gas a tremendous significance to the aeronautical engineer. The Research and Development Department of Walter Kidde & Company has evolved interesting applications of power actuation using carbon dioxide under high pressure. Please consult us, if we can assist you.

Research and Development Department of

Walter Kidde & Company, Inc., 349 West Street, Bloomfield, N. J.

KEEP 'EM FLYING!

WITH *Eclipse* AIRCRAFT ACCESSORIES

PAN-AMERICAN
PACIFIC CLIPPER

WITH running lights out and radio silenced, Pan American Airways' Pacific Clipper swung from its scheduled course to elude invading enemy warplanes and continued, in accordance with a "planned procedure", on a 24,686 mile course around the world. The resourcefulness exemplified by flight personnel and the steady, unfaltering performance of equipment throughout the 209½ hours of flying operation is an achievement of which Pan American can be justifiably proud.

To the Pan American engineers engaged in the selection, operation and maintenance of equipment, Eclipse Aviation offers congratulations for a job well done. Proud are we of the part that Eclipse Aircraft Accessories played in this historic flight. More than ever before, air line operation is responsible for the maintenance of safe and speedy transportation throughout the Western Hemisphere. Today, with the Americas fighting a common enemy together, AIR LINES have truly become LIFE LINES OF DEFENSE.

Eclipse Products used in the Pan American Pacific Clipper

E-160 Direct Cranking Electric Starters, Battery Booster Coils, Solenoid Starting Relays, Engine Driven Generators, Engine Driven Autosyn Alternators, Current Regulators, Battery Operated Autosyn Dynamotors, Air Check Valves, Oil Separators, De-Icer Distributing Valve, De-Icer 4-Way Control Valve, Propeller Anti-Icer Pump, Flap Retracting Motor, Fluid Check Valve, Motor Driven Hydraulic Pump for Propeller Feathering, Electric Propeller Governor Control and Switch.

LET'S GO! U.S.A. KEEP 'EM FLYING!

ECLIPSE AVIATION

DIVISION OF BENDIX AVIATION CORPORATION

BENDIX, NEW JERSEY, U. S. A.

ECLIPSE

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For Dependable Operation IT PAYS TO *FLY Eclipse-Equipped*